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Gas Chromatography Laboratory Operation

Rockwell International
Creve Coeur, MD

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A gas chromatography laboratory was set up to analyze air samples collected in Teflon bags and stainless steel tanks. Samples were analyzed for total hydrocarbons, methane, CO, and C_2-C_{10} hydrocarbons. A total of 455 samples, including replicates, were analyzed during the summer and fall of 1976. Many samples were collected at 12 of the Regional Air Monitoring Systems (RAMS) sites to yield data on spatial and temporal distributions of hydrocarbons. Additional sampling was performed to study ethylene contamination in and around RAMS stations. Roadway samples were collected to determine the composition of freshly emitted vehicular pollution. Quality control audits indicated good system performance during the study. Replicate samples indicated good reproducibility for samples stored for as long as six days in the Teflon bags.

All data, including sums of paraffins, olefins, aromatic, and total non-methane hydrocarbons are stored in the RAPS Data Bank at Research Triangle Park, North Carolina.

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REGIONAL AIR POLLUTION STUDY

Gas Chromatography Laboratory Operation

by

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OFFICE OF RESEARCH AND DEVELOPMENT
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ABSTRACT

A gas chromatography laboratory was set up to analyze air samples collected in 100-liter Teflon bags and 8-liter stainless steel tanks. Samples were analyzed for total hydrocarbons (THC), methane, and CO on a Beckman Model 6800 gas chromatograph, and for C_2-C_{10} hydrocarbons on a Perkin-Elmer Model 900 gas chromatograph equipped with dual columns, connected to a PEP-1 data system. A phenyl isocyanate column resolved the C_2-C_5 compounds and a support-coated-open-tubular squalane column was used for C_6-C_{10} compounds. Experiments were performed to establish optimun temperature programming, flow rates, and column lengths to yield good compound resolution within reasonable elution times.

A total of 455 samples including replicates, were analyzed during the summer and fall, 1976. Of these samples, 292 were collected at 12 of the Regional Air Monitoring System (RAMS) sites to yield data on spatial and temporal distributions of hydrocarbons. All were analyzed for THC, methane, CO, and C_2-C_5 hydrocarbons. In addition, early morning (0600-0800) samples were analyzed for C_6-C_{10} compounds. Portions of these data are included in this report. Sampling results indicate excessive concentration of ethylene within some of the RAMS stations, probably from the ozone monitoring system used at all RAMS sites. Some samples collected during roadway studies were reanalyzed on subsequent days; results showed good reproducibility using the Teflon bags. System reproducibility from quality control checks was good; with analyses of standards indicating deviations generally less than 5 percent.

All data, including the sums of paraffins, olefins, aromatics and total non-methane hydrocarbons are stored in the RAPS Data Bank at Research Triangle Park, North Carolina.

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1.0 INTRODUCTION

The Regional Air Pollution Study (RAPS) is directed toward a quantitative understanding of urban pollution, including the monitoring of ambient levels of pollution, the gathering of micro-meteorological data and of a comprehensive emission inventory.

The gas chromatography laboratory was established to support these investigations. In particular it was charged with the collection and analysis of samples of hydrocarbons C_1 - C_{10}, carbon monoxide and tracer gases in ambient air. In order to find a more accurate and selective method for identifying hydrocarbons C_2 - C_{10}, modifications were made on the Perkin Elmer 900 Gas Chromatograph such that detailed analyses of these hydrocarbons in the parts-per-billion range could be performed. Samples were run and the results were tabulated and classified.

2.0 SUMMARY

The gas chromatography laboratory modified the analysis of C_2 - C_{10} hydrocarbons from the methods described in the final reports of Task Orders 53 and 103. A Perkin Elmer (P.E.) Model 900 gas chromatograph equipped with dual columns and a PEP-1 data system was used. A phenyl isocyanate (Dura Pak) column gave good resolution for C_2 - C_5 compounds and a Support-Coated-Open-Tubular (SCOT) squalane column was used to analyze hydrocarbons C_6 - C_{10}. The modifications included shortening the SCOT squalane column from 30.48 meters to 15.24 meters and raising the initial temperature from -3°C to 25°C. These changes permitted the accurate and methodical identification of hydrocarbons C_6 - C_{10} on the squalane column with an analysis time of 55 minutes. As result of these modifications the precision of the analyses done on the squalene column was improved as indicated by the reproducibility of the analysis of a toulene standard over a three month interval.

A total of 455 samples of ambient air (including triplicate analyses) was analyzed during the summer and fall intensives and for special studies during this task order period. These samples were collected from RAMS stations and roadside locations and were analyzed for total hydrocarbons (THC), carbon monoxide (CO) and methane (CH_4) on the Beckman Model 6800 gas chromatograph and hydrocarbons C_2 - C_{10} on the P.E. 900 gas chromatograph.

Two hundred and ninety-two ambient air samples from twelve RAMS sites were analyzed during the summer and fall intensives. All of the samples were analyzed for THC, CH_4, and CO (Beckman 6800) and C_2 - C_5 hydrocarbons (P.E. 900). The 0600-0800 (CST) samples were analyzed for THC, CH_4 and CO and C_2 - C_{10} hydrocarbons (P.E. 900). Tables containing a portion of these data are in Appendix C.

High concentrations of ethylene at RAMS sites 101 and 124 led to a special study of ethylene concentration. The samples were collected in 100 litre Teflon bags (5 mil thickness) and 8 litre stainless steel tanks, in

and around the stations as requested by the EPA Task Coordinator. The results of this special study indicate that in certain cases the values reported for ethylene may be biased by fugitive emission of ethylene from the ozone monitor and associated hardware found in each of the RAMS stations.

Roadway samples were analyzed by the gas chromatography laboratory for a special study conducted by the EPA Task Coordinator. Some of the samples were reanalyzed on subsequent days. Relatively good reproducibility was obtained using the 5 mil Teflon bags.

To insure quality control, standards were run daily and records maintained of the areas and peak heights. The triplicate analyses of the first bag sample each day showed a standard deviation of less than 2.0 ppbC for the task order period.

All of these data, including the sums of the paraffins, olefins, aromatics and total non-methane hydrocarbons, were processed and prepared for entry into the RAPS Computer Data Bank, Research Triangle Park (RTP), North Carolina.

3.0 DEVELOPMENT OF THE SQUALANE COLUMN

In the past, the gas chromatography laboratory experienced some difficulty in the analysis of C_5 - C_{10} compounds on the squalane column. During Task Orders 53 and 103 periods the initial 60.96 meters x 0.05 cm squalane SCOT column was reduced to 30.48 meters because of excessive column bleed (1, 2). A Carbowax 20M-TPA on Chromosorb W-AW post column was added during Task Order 53 but was replaced with glass beads during Task Order 103 because of the problems incurred with the Carbowax column. A potassium carbonate (K_2CO_3) pretrap was added during Task Order 53 in order to minimize the effect of water and polar compounds in the squalane system. Figure 1 is an example of hydrocarbons C_2 - C_{10} analyzed during both task order periods. Because of the length of time required for analysis and the broadening of the peaks, C_9 - C_{10} were not really identified. Alternate methods of analysis were explored.

The literature was searched and the problem examined in a systematic manner with the aim of developing a method of analysis that: (1) provided a reliable basis for identification of hydrocarbons on the squalane SCOT column; (2) could be easily incorporated in the equipment of the laboratory; and (3) preferably employed only one column for the analyses of compounds C_2 - C_{10}.

3.1 LITERATURE SEARCH

Extensive work on the squalane SCOT column has been reported in the literature. W. O. McReynolds (3) and others described the analyses of hydrocarbons C_2 - C_{10} on 60.96 and 30.48 meters x 0.05 cm columns. The problem encountered was the length of time required to complete the analyses since in some cases five or more hours were required. L. S. Ettre (4) described the analysis of C_1 - C_9 hydrocarbons on a 30.48 meter x 0.05 cm column requiring only 35 minutes. The method, although attractive, had some shortcomings: it did not identify all the compounds in which the gas

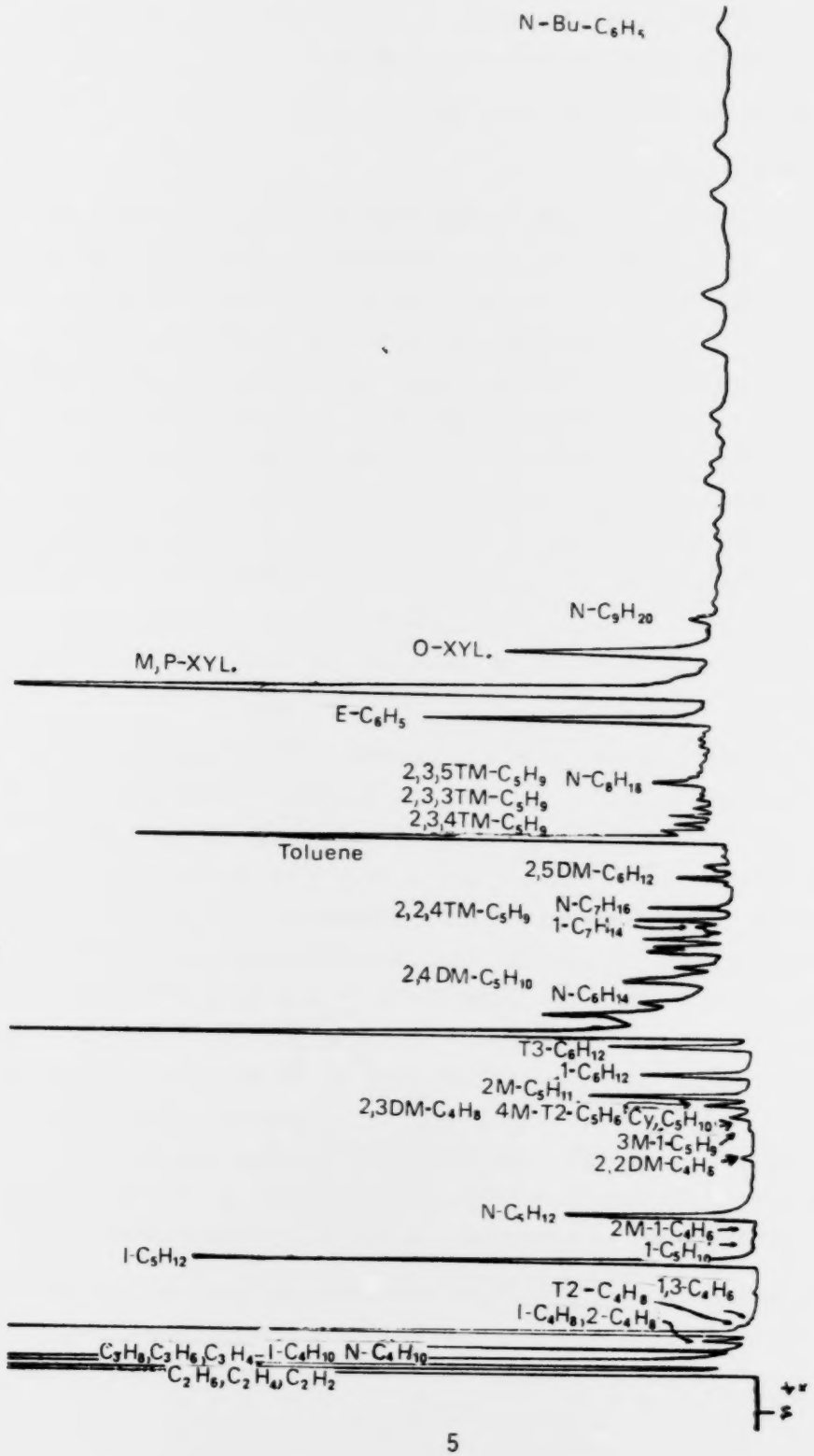

FIGURE 1. SQUALANE COLUMN ANALYSIS OF ATMOSPHERIC SAMPLE FOR C_2 - C_{10} HYDROCARBONS

chromatography laboratory was interested, e.g. ethyl benzene, the xylenes and decanes; therefore, modifications had to be made.

3.2 DEVELOPMENT OF THE 60.96 AND 30.48 METER COLUMNS

3.2.1 Preliminary Experiments

Two 100 litre Teflon bags were filled with 50 litres of Scott-Marrin ultrapure air by using a mass flow meter which was corrected for standard temperature and pressure. Bag 1 was injected with 10 ml of each of the following gases using the appropriate size precision sampling syringe: methane (CH_4), ethane (C_2H_6), ethylene (C_2H_4), propane (C_3H_8), acetylene (C_2H_2), isobutane ($I\text{-}C_4H_{10}$), normal butane ($N\text{-}C_4H_{10}$); and 0.05 ml each of the following liquids: isopentane ($I\text{-}C_5H_{12}$), normal pentane ($N\text{-}C_5H_{12}$), hexane (C_6H_{14}), heptane (C_7H_{16}), toluene (C_7H_8), octane (C_8H_{18}), ethyl benzene (C_8H_{10}), meta xylene (C_8H_{10}), ortho xylene (C_8H_{10}), nonane (C_9H_{20}), mesitylene (C_9H_{12}) and decane ($C_{10}H_{22}$). After equilibration, one milliliter of this mixture was injected into Bag 2 (dilution bag). The diluted contents of Bag 2 were analyzed on the 60.96 and 30.48 meters x 0.05 cm squalane columns.

The 60.96 and 30.48 meters squalane columns provided acceptable separation for hydrocarbons C_1 - C_7; but, the heavier hydrocarbons (C_8 - C_{10}) took an exceptionally long time to elute. The physical conditions (flow rate and temperature) were the same as described in the final report for Task Orders 53 and 103. In an attempt to overcome the elution problem with the heavier hydrocarbons, the initial oven temperature was varied from -3°C to 0°, 3°, 15° and 25°C and the final temperature from 75°C to 90°C and 115°C. The carrier gas flow rate was increased from 12 cc/min. to 15 cc/min. The results of these changes were not satisfactory; an increase in temperature and carrier gas flow rate yielded no data on C_1 - C_6 hydrocarbons (they elut d in the initial 15 seconds) and the higher temperatures yielded significant shifts in the baseline of the chromatograph at 90°C and above. These changes had little or no effect on the heavier hydrocarbons.

The 15.24 meter squalane SCOT column was then employed and was found suitable for the analyses of C_6 - C_{10} hydrocarbons. It was found that hydrocarbons C_1 - C_5 elute too fast (within the first two minutes) to be

properly identified. The hydrocarbons were analyzed under the same physical conditions (temperatures and flow rates) as described for the 60.96 and 30.48 meters columns. The initial temperature was increased to 25°C and the final temperature increased to 90°C; the carrier gas flow rate remained at 12 cc/min. These conditions proved ideal for the analysis of hexane, which eluted at 3.6 minutes, through normal butyl benzene, which eluted at 55 minutes. It was then decided to continue to employ two columns in the P.E. 900 in the analyses of hydrocarbons C_2 - C_{10}. Figures 2 and 3 show typical examples of ambient air analyzed with the two columns employed in the P.E. 900 gas chromatograph.

3.2.2 C_2 - C_5 Analysis on the Phenyl Isocyanate (Dura Pak) Column

During the preceding task order period (103) C_2 - C_5 hydrocarbons were analyzed on the 1.83 meter x 0.63 cm ID phenyl isocyanate (Dura Pak) column where the initial oven temperature was held at 0° for 3 minutes then programmed at a rate of 6°/minute until normal pentane ($N\text{-}C_5H_{12}$), the last compound analyzed on the column, eluted. The whole analysis took 13 minutes to complete.

With the modified procedure, initial oven temperature at 25°C for 8 minutes, the programmed at a rate of 2°/minute and employing the Dura Pak column, normal pentane elutes in 10 minutes. Figures 2 and 4 show that the change in environment had no adverse effect on the C_2 - C_5 analysis.

3.2.3 Use of Dual Columns

The analysis of hydrocarbons C_2 - C_{10} was accomplished by using two columns connected to two flame ionization detectors in the Perkin Elmer Model 900 gas chromatograph (Figure 5 shows the schematic diagram of the analysis system). Hydrocarbons C_2 - C_5 were analyzed on a 1.83 meter x 0.63 cm ID phenyl isocyanate (Dura Pak) column that was conditioned by heating it at 115°C with helium flowing through over a 24 hour period. Hydrocarbons C_6 - C_{10} were analyzed on a 15.24 meter x 0.05 cm ID squalane SCOT column that was conditioned at 115°C with helium flowing through over a 60 hour period. Both columns shared the same oven which was held at 25°C for eight minutes, then programmed at a rate of 2°C per minute until the

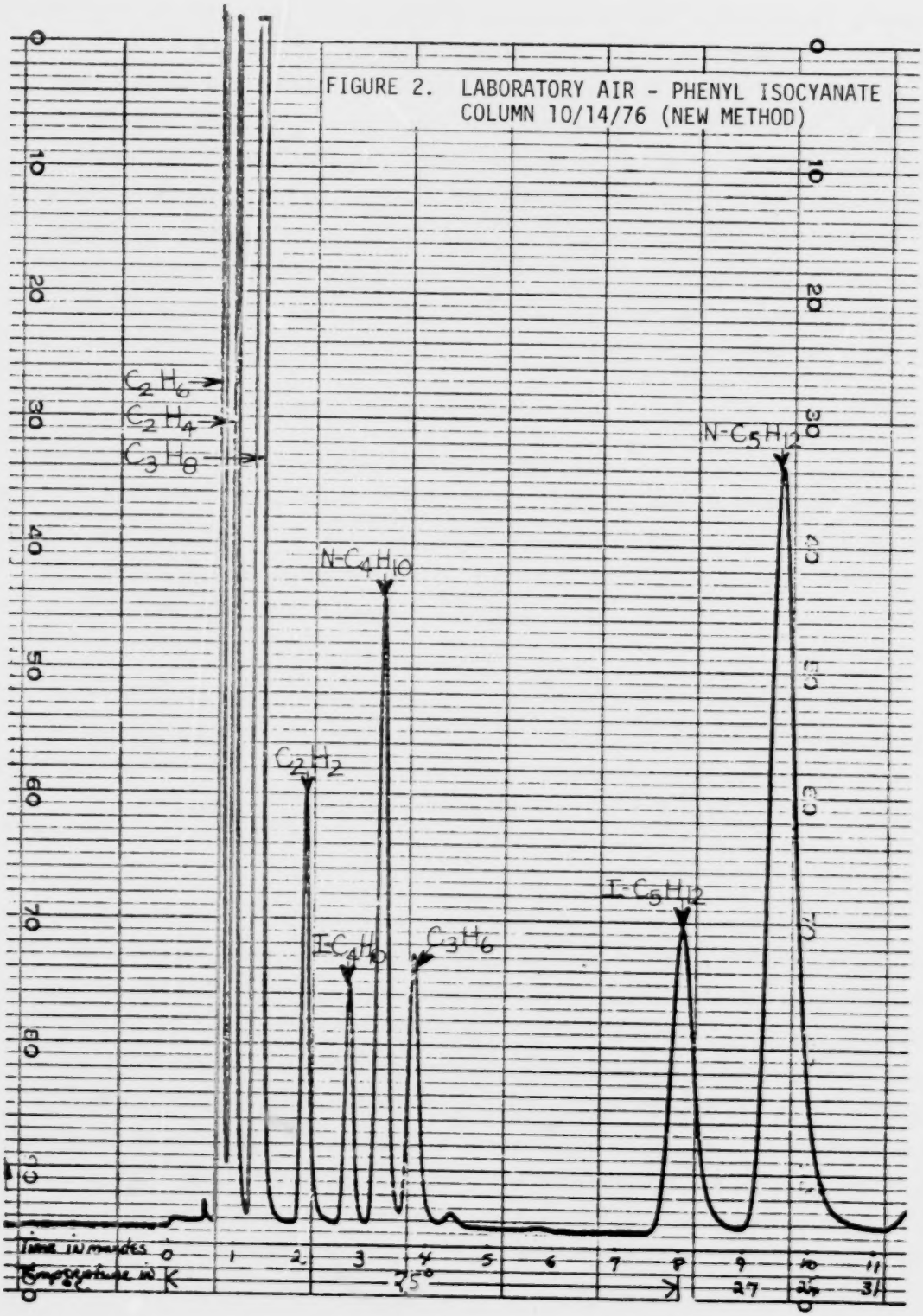

FIGURE 2. LABORATORY AIR - PHENYL ISOCYANATE COLUMN 10/14/76 (NEW METHOD)

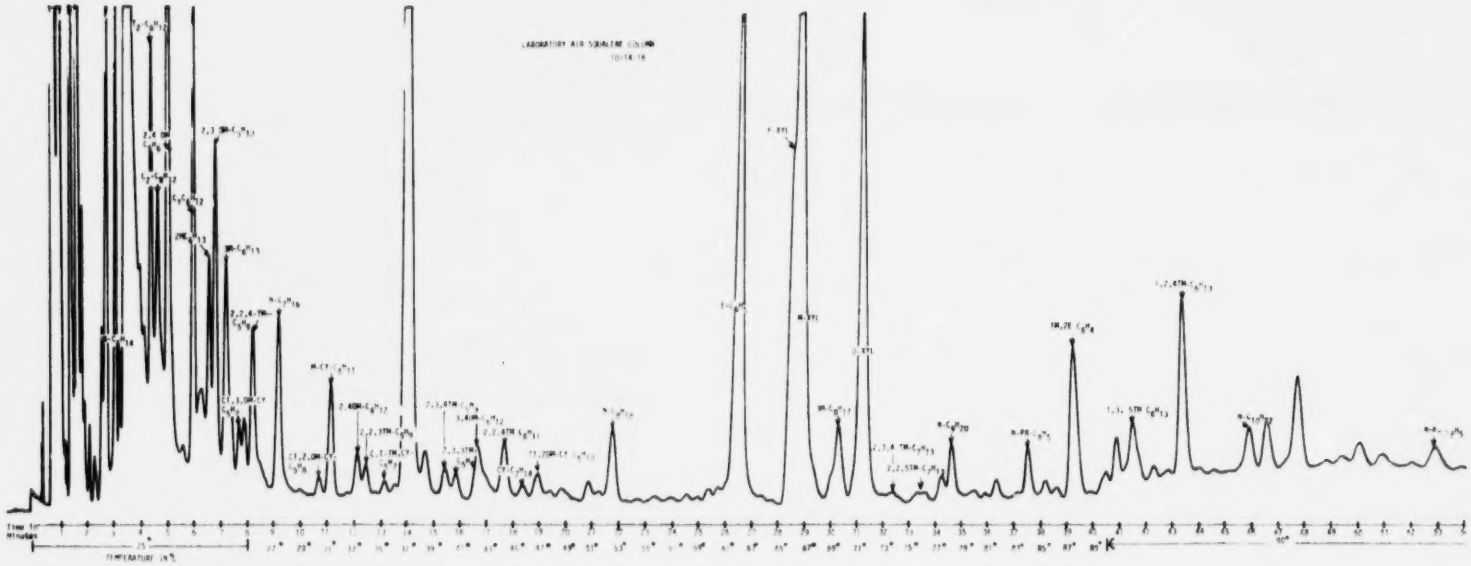

FIGURE 3. SAMPLE OF AMBIENT AIR ON THE SQUALANE COLUMN
(NEW METHOD)

FIGURE 4. HYDROCARBONS C_2 - C_5 ON DURA PAK , 3 MINUTES AT 0°, PROGRAMMED AT 6°/MINUTE (Old Method)

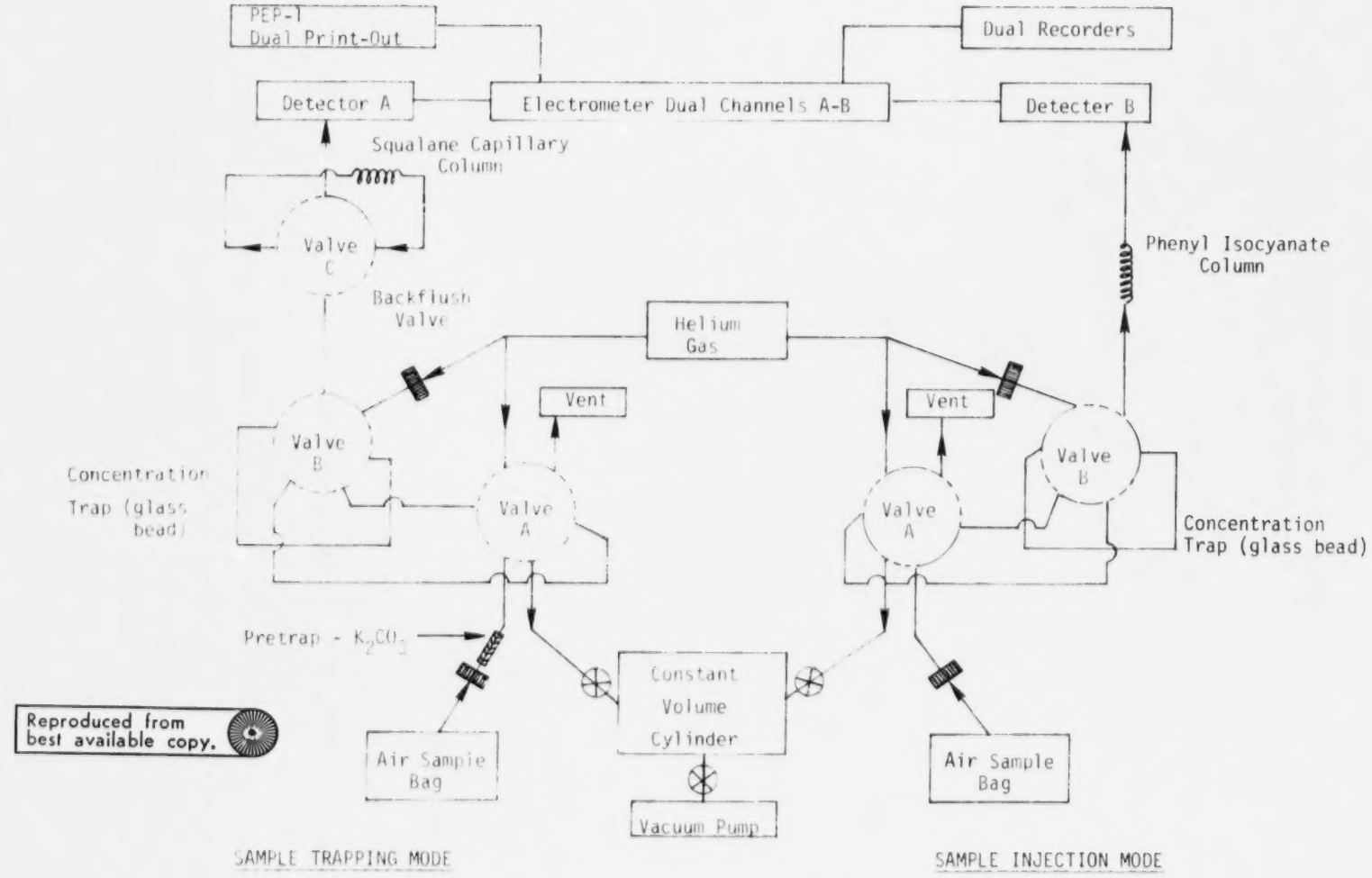

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FIGURE 5. ATMOSPHERIC ORGANICS ANALYSIS SYSTEM - P.E. 900

system reached 90°C, where it was held for the remainder of the analysis. The total analysis times were 10 minutes for hydrocarbons C_2 - C_5 on the Dura Pak column and 55 minutes for hydrocarbons C_6 - C_{10} on the squalane column.

3.2.4 Response Factors For Hydrocarbons C_6 - C_{10}

In order to obtain accurate response factors (RF) for C_6 - C_{10} hydrocarbons for the squalane column, two synthetic mixtures of the various compounds were carefully prepared, using the procedure described in Section 3.2.1, then analyzed on the P.E. 900 gas chromatograph. The concentrations of the liquid compounds were computed in the following manner.

Example: Toluene

$$\text{Bag-1} \quad \frac{22.4 \times \frac{295^\circ}{273^\circ} \text{ l/mole} \times \frac{1 \text{ mole}}{92.15 \text{ gm}} \times 0.8669 \frac{\text{gm}}{\text{ml}} \times 0.05 \text{ ml}}{50 \text{ litres of ultrapure air}} = 228 \text{ ppm}$$

$$\text{Bag-2} \quad \frac{1 \text{ ml of contents of Bag 1} \times 228 \text{ ppm}}{50 \text{ litres of ultrapure air}} \times 7 \text{ carbon number} = 31.9 \text{ ppbC}$$

The PEP-1 computer was programmed in such a manner (area normalization) that only the areas of the selected compounds were computed. The response factors for the hydrocarbons were calculated in the following manner.

Example: Toluene

$$RF = \frac{\text{concentration}}{\text{area} \times 5}$$

$$RF = \frac{31.9}{2.044 \times 5}$$

$$RF = 3.12$$

Figure 6 shows an example of a chromatograph that was used in calculating the response factors for hydrocarbons C_6 - C_{10}. It was observed that although equivalent amounts of each hydrocarbon were in the final mixture, the detector of the P.E. 900 indicated varying integrated peak areas. Table 1 shows experimentally determined response factors for C_2 - C_{10} hydrocarbons. In instances where the pure compound could not be obtained for analysis, the response factors were estimated (Table 2).

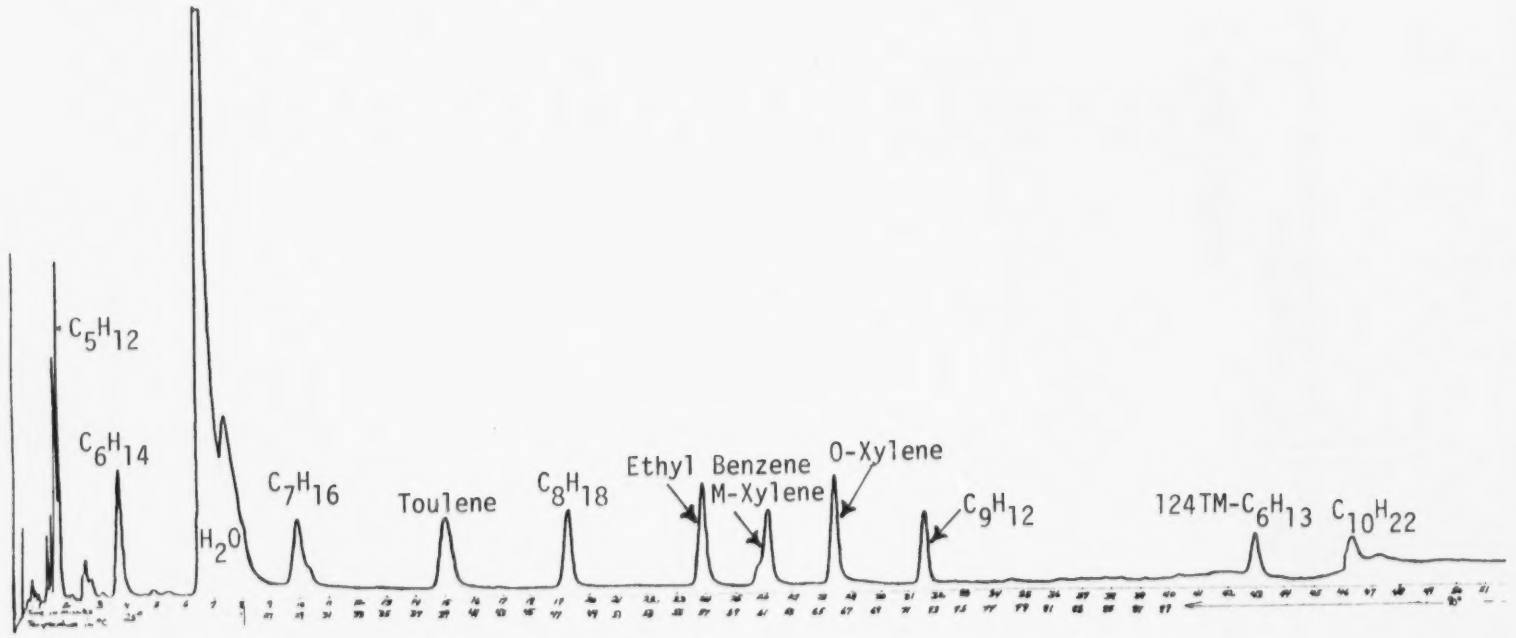

FIGURE 6. QUANTITATIVE STUDY OF HYDROCARBONS C_5 - C_{10} 6/17/76

TABLE 1. EXPERIMENTALLY DETERMINED RESPONSE FACTORS FOR C_2 - C_{10} HYDROCARBONS

COMPOUNDS	RESPONSE FACTOR (RF)
Ethane	3.91
Ethylene	3.85
Propane	4.12
Acetylene	4.84
Isobutane	4.50
N-Butane	4.16
Propylene	4.36
Iso-Pentane	4.11
N-Pentane	4.10
N-Hexane	4.24
Trans 2-Hexene	3.72
Cis 2-Hexene	3.72
Cyclobexane	3.74
N-Heptane	2.98
Toluene	3.12
Octane	3.26
Ethyl Benzene	3.39
Methyl Xylene	3.61
Ortho Xylene	3.67
Nonane	2.99
N-Propyl Benzene	3.94
Mesitylene	3.88
N-Decane	4.34
N-Butyl Benzene	4.16

TABLE 2. ESTIMATED RESPONSE FACTORS FOR C_6 - C_{10} HYDROCARBONS

COMPOUNDS	RESPONSE FACTOR (RF)
Olefins C_6 to C_{10}	3.70
Paraffins C_6 to C_{10}	3.50
Alkyl Aromatics	3.80

4.0 ANALYSIS OF RAMS STATIONS SAMPLES DURING THE SUMMER AND FALL INTENSIVES OF 1976

During the period of performance of Task Order 113, the gas chromatography laboratory analyzed atmospheric samples from various RAMS stations. Sampling commenced on 23 June 1976 with a collection of two or four samples per site, five sites per day, two days per week. The choice of sites and times of sampling were determined by the EPA Task Coordinator. The sampling period ended on 18 November 1976.

4.1 SELECTION OF SAMPLING BAGS AND TANKS

Ambient air samples were collected in Teflon bags and stainless steel tanks. The 100 litre Teflon bags (5 mil thickness) were checked for leaks by filling the bags with approximately 60 litres of helium, then going over them thoroughly (especially the seams and Teflon fittings) with a Gow Mac helium leak detector. The detector was zeroed, then the detector's nozzle was passed over the bag. If the gauge remained at zero, the bag was leak free; but, if the gauge moved from zero, the bag contained a leak. Leaks that occurred around the fittings were repaired by tightening them. Bags with leaks in their seams were set aside to be repaired at RTP in Durham, N.C. The "leak free" bags, filled to capacity with helium, were left on the shelves overnight, then again checked for leaks. These bags were purged three times with helium then filled with approximately 60 litres of ultrapure air and again left on the shelves overnight. The bags were analyzed on the Beckman 6800 for THC, CH_4 and CO and the P.E. 900 for C_2 - C_{10} hydrocarbons. Bags possessing more than 2 ppbC of hydrocarbons were put aside; those having less than 2 ppbC hydrocarbon contamination were placed into circulation to be used in the RAMS sampling system. A supply of at least 25 "good bags" were kept in the system at all times. Bags were replaced in the system as needed. Figures 7 and 8 show the background chromatographs of a typical good bag.

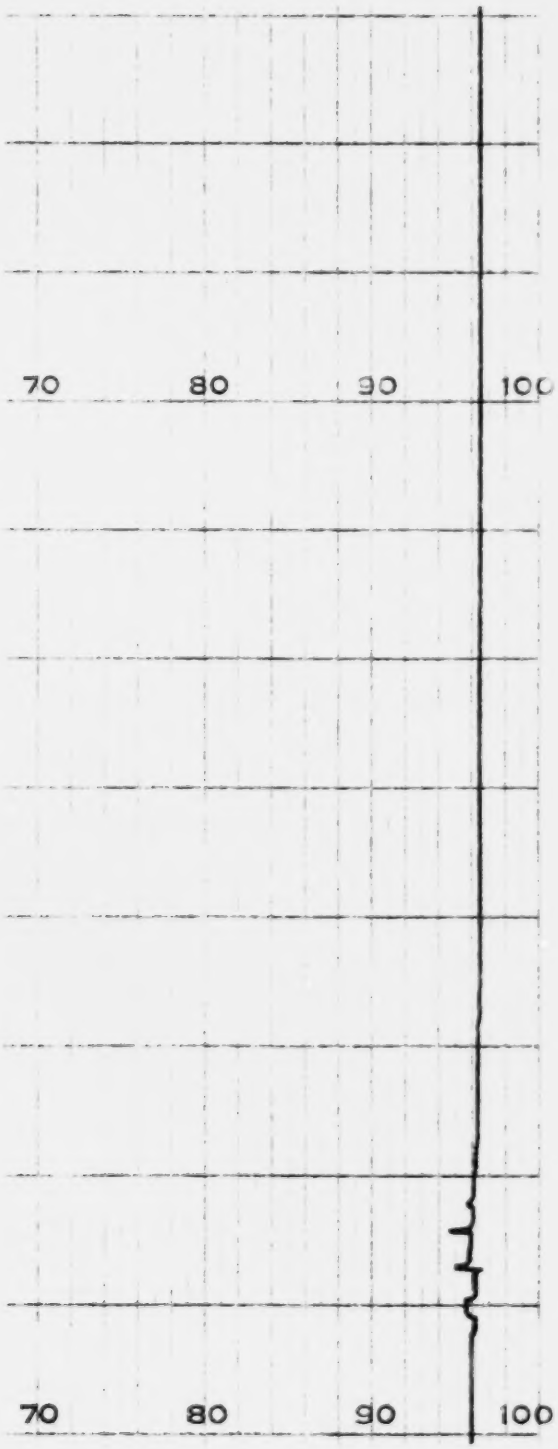

FIGURE 7. BAG 17 ANALYZED ON THE PHENYL ISOCYANATE COLUMN 6/9/76

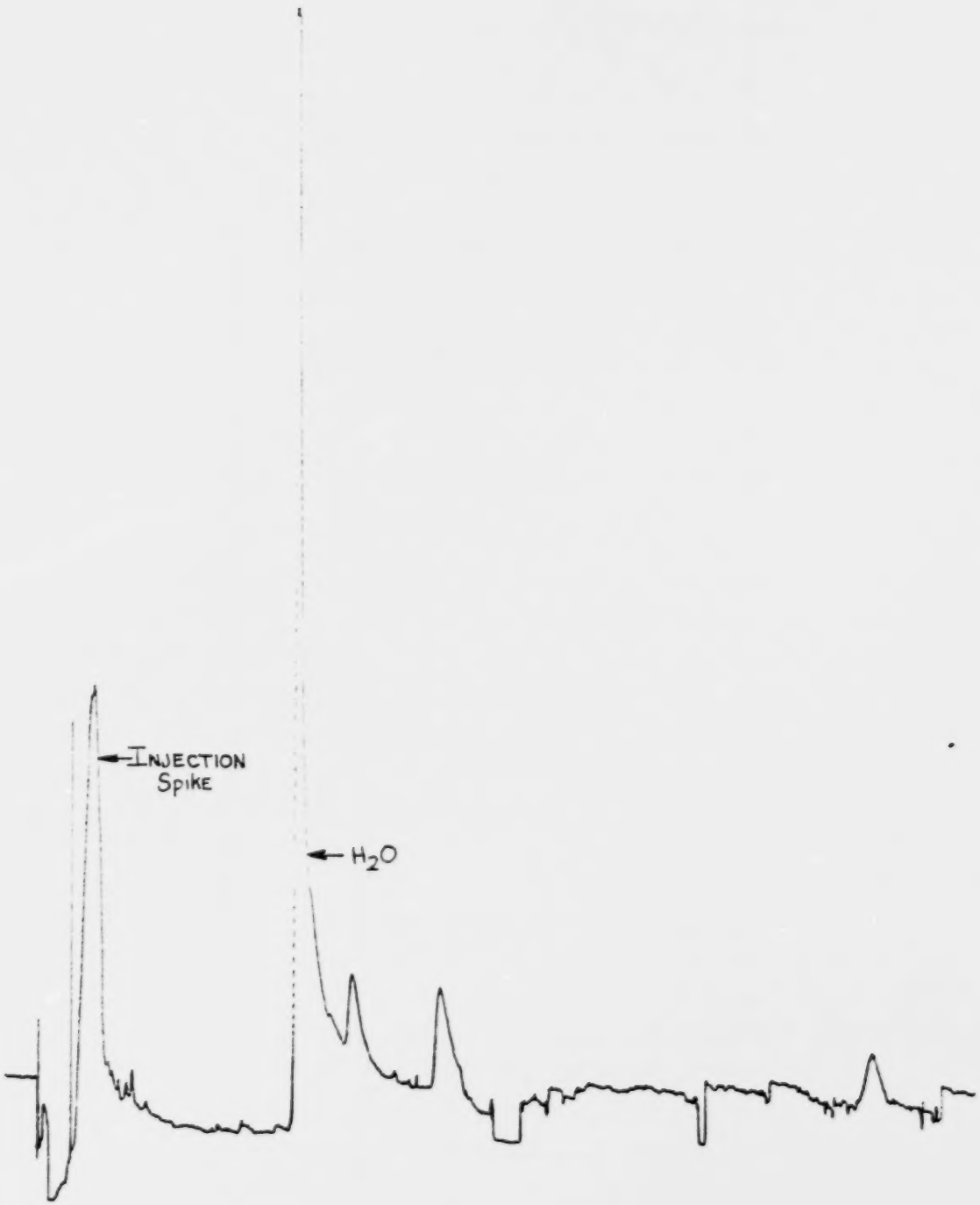

FIGURE 8. BAG 17 ANALYZED ON SQUALANE COLUMN 6/19/76

During the 1976 fall intensive and special studies periods, four 8 litre stainless steel tanks were introduced into the sampling system. The tanks were fitted with a vacuum gauge on the rear and a two way needle valve on the front. The tanks were purged with helium, pressurized to approximately 30 psi with ultrapure air, and left to stand overnight in order to ascertain the amount of leakage and the degree of hydrocarbon contamination. The contents of the tank were analyzed on the P.E. 900 gas chromatograph the following day. The air in the tanks was removed by attaching a regulator with a quick connect fitting to the two-way valve. The valve was opened all the way so that fractionating of the gases would not occur and the regulator was partially opened. The quick connect fitting was joined to its counterpart on the P.E. 900 in injection mode (see Figure 5). Three of the four tanks were found suitable for sampling. Figure 9 shows an example of a chromatogram of a hydrocarbon-free stainless steel tank.

4.2 AMBIENT AIR SAMPLING

The gas chromatography laboratory was responsible for the bag preparation, placing bags at the RAMS stations, sample transportation, sample analyses, data validation and computer tape and printout distribution of the data. These were accomplished as follows:

4.2.1 Bag Preparation and Sample Collection

In order for the Teflon bags to be in place at the RAMS stations at 0600 hours CST, they were purged three times with helium and stored in a box at 0400 on the sampling day. The bags were transported to the various sites in a van and placed in the bag boxes at the RAMS stations. Figure 10 shows the sampling system and the flow diagram of the system at each site. A glass wool filter was used for the removal of ozone and particulants.

One bag was placed at each site in each bag box and upon command from the central computer at 0600 CST, the port between 1 and 2 would open on box 1 (see Figure 10) and air would flow through for two hours at an approximate rate of 833 cc/minute. (This rate varied somew twhat from station to station owing to the idiosyncrasy of the equipment at that station.) The port between 1 and 2 would open and ambient air would flow through 2

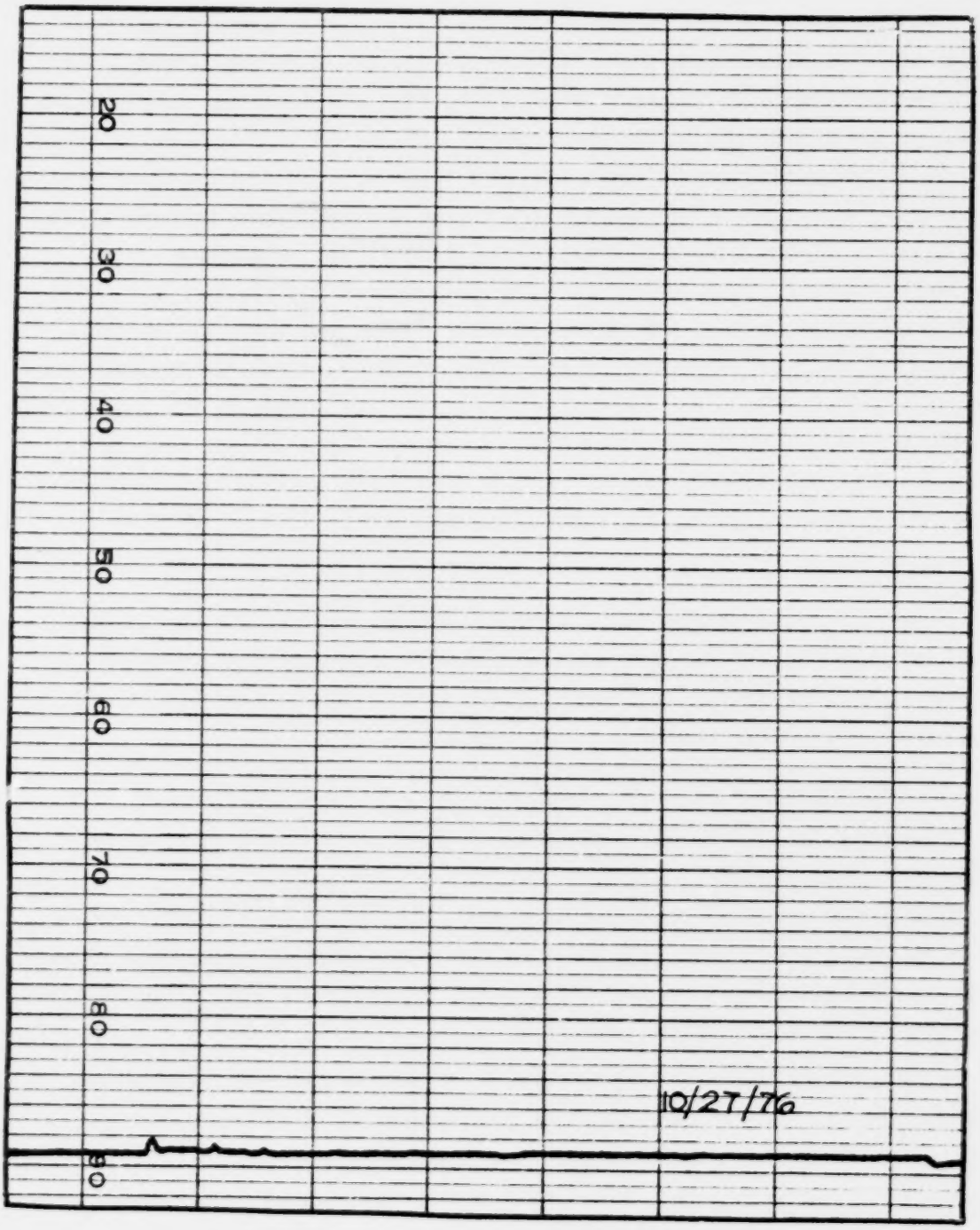

FIGURE 9. BACKGROUND OF STAINLESS STEEL TANK

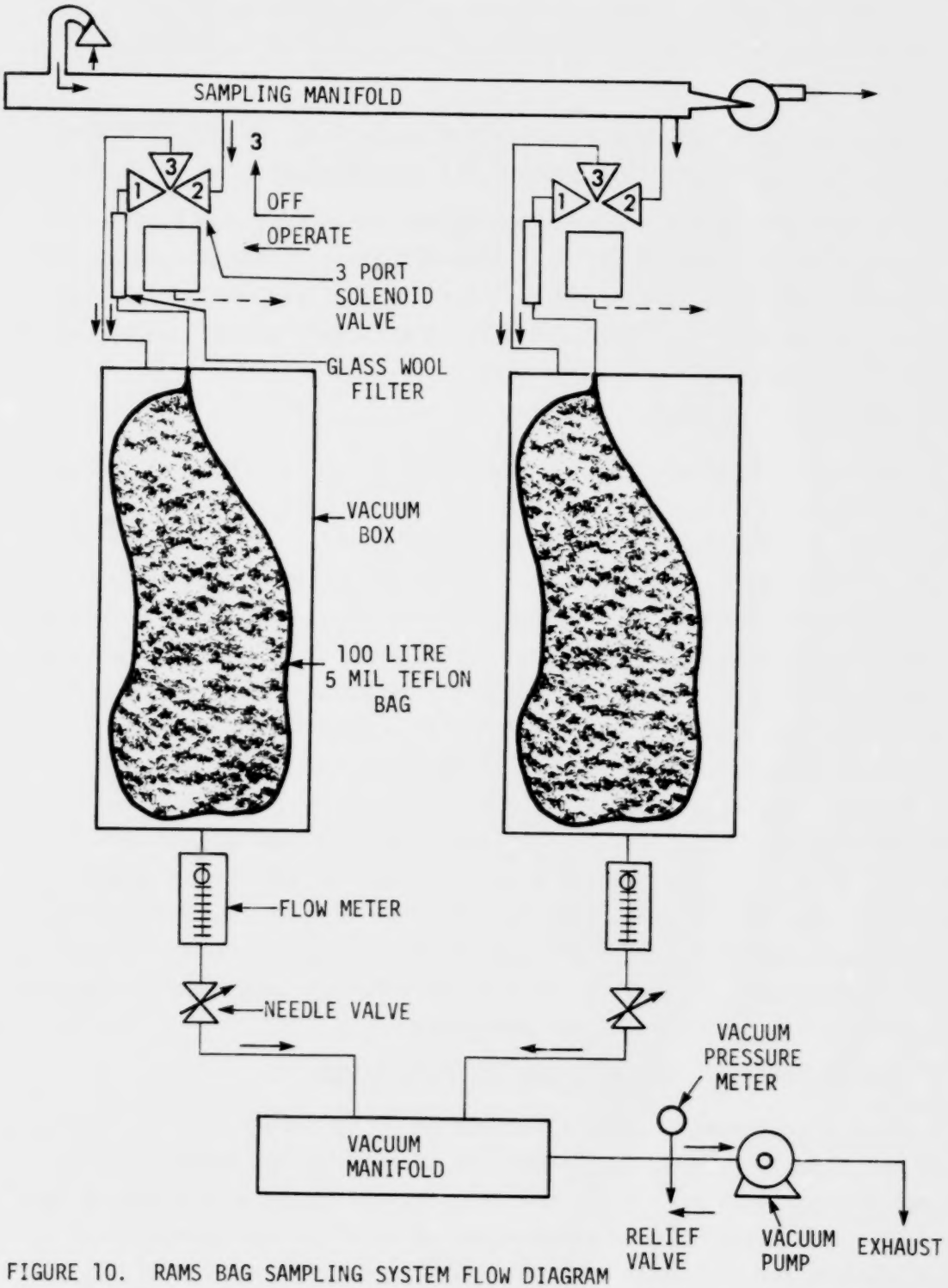

FIGURE 10. RAMS BAG SAMPLING SYSTEM FLOW DIAGRAM

to 1, then into the bag. Although port 3 was closed, the vacuum pump continued to evacuate the air in the air box; this caused the ambient air to fill the bag.

After two hours, a command from central would shut off the air flow on box 1 and turn on the air flow of box 2 and the procedure would be repeated.

The 0600 ambient air samples were removed and an empty bag put in its place in order to collect a sample at 1000-1200 hours. This procedure continued until the final samples were collected at all stations at 1200-1400 hours. The ambient air samples, protected from direct sunlight, were transported back to the laboratory for analyses.

4.3 AMBIENT AIR SAMPLING

Ambient air samples, which were collected in the 100 litre Teflon bags at the RAMS stations over a two hour period of time, were analyzed for THC, CH_4 and CO on the Beckman 6800 and for hydrocarbons C_2 - C_{10} on the Perkin Elmer 900 (procedures are described in Appendices A and B). Initially all bag samples were analyzed for all compounds but this proved too difficult due to the late arrivals of the 0600-0800 and 0800-1000 samples at the laboratory (13:00-14:00 hours), the number of samples (maximum of 16) and the time required to complete the squalane analysis (1.5 hours including printout and turnaround times). The following changes were made by the EPA Task Coordinator: ambient air samples that were collected at 0600-0800 hours were analyzed for THC, CO and C_1 - C_{10} and subsequent bags were analyzed for THC, CO and C_1 - C_5. Table 3 shows the number of ambient air samples analyzed by the gas chromatography laboratory during this Task Order period. The analyses commenced immediately upon arrival of the bags at the laboratory and continued until all analyses were complete for all samples, which required the operation of two shifts at the laboratory.

4.4 DATA VALIDATION, INTERPRETATION AND DISTRIBUTION

Each chromatogram of ambient air samples of the summer and fall intensive was visually analyzed by the EPA Task Coordinator and laboratory personnel working together. At the conclusion of the Intensive and data validation, the arithmetic mean and standard deviation of the concentrations of all time segments were calculated for total hydrocarbons (THC), methane (CH_4),

TABLE 3. AMBIENT AIR SAMPLES ANALYZED IN THE GAS CHROMATOGRAPHY LABORATORY 1976

MONTH	NUMBER
June	20
July	98
August	96
September	9
October	0
November	69
TOTAL	292

carbon monoxide (CO) and acetylene (C_2H_2). Table 4 shows data on a station by station basis. The sums of the parafins, olefins, aromatics and total non-methane hydrocarbons per sample were calculated and recorded. The validated data, on one copy of a 600 foot, 9 track, 800 BPI, odd parity magnetic data tape, along with two copies of the printout were given to the EPA Task Coordinator. Appendix C contains some of the results of the data collected during the summer and fall intensives.

The carbon monoxide to acetylene ratios were computed from the arithmetic mean for each station where acetylene was consistently analyzed. These data are shown in Table 5. It should be noted that acetylene was not present in sufficient quantities to be analyzed at all times for many of the RAMS sites.

TABLE 4. SUMMARY OF SUMMER AND FALL INTENSIVES 1976*

	THC		CH_4		CO		C_2H_2	
RAMS STATIONS	$\bar{X}$	S_x	$\bar{X}$	S_x	$\bar{X}$	S_x	$\bar{X}$	S_x
Summer 101	3283	1137	1880	193	1101	530	12	8
Summer 102**	2660	306	1972	97	935	214		
Summer 103	2328	424	1860	273	763	412	4	2
Summer 108	2223	270	1872	98	603	388		
Summer 113	1874	78	1912	82	957	167		
Summer 114	2613	912	1851	308	599	302	7	9
Summer 115	2427	908	1788	147	498	213	3	2
Summer 118	2791	1310	1770	133	479	301	3	2
Summer 121	1960	311	1872	44	364	183		
Summer 122	2939	1771	1864	212	607	240	5	2
Summer 124	2264	382	1931	402	579	214	3	1
Fall 101	2906	788	1734	240	1815	1322	33	26
Fall 103	2676	817	1739	367	1073	844	15	14
Fall 114	2451	1299	1541	581	1187	1392	19	22
Fall 115	2321	417	1637	225	666	388	9	7

$\bar{X}$ Mean
S_x Standard Deviation

* Concentrations in ppbC

** Values artificially high due to small amount of data

TABLE 5. AVERAGE CARBON MONOXIDE TO ACETYLENE RATIOS

RAMS STATION	RATIO OF CO TO C_2H_2
Summer 101	96
Summer 103	177
Summer 114	84
Summer 115	143
Summer 118	142
Summer 122	127
Summer 124	196
	$\bar{X} = 138$ $S_x = 40$
Fall 101	56
Fall 103	72
Fall 114	62
Fall 115	71
	$\bar{X} = 65$ $S_x = 8$

5.0 SPECIAL STUDIES

Special studies and audits were carried out by the gas chromatography laboratory, as requested by the EPA Task Coordinator. These included roadway sampling, ethylene concentration verifications and audits on various gas samples.

5.1 COLLECTION AND ANALYSES OF ROADWAY SAMPLES

The EPA Task Coordinator requested and collected roadway samples for the gas chromatography laboratory to analyze THC, CO and C_1 - C_{10} hydrocarbons. A mobile air monitoring laboratory was used as the vehicle from which the samples were collected from heavily traveled thoroughfares during the morning rush hours. The bags used as containers for ambient air samples were purged three times with helium, filled with approximately 60 litres of helium, then left with the EPA Task Coordinator the day prior to sampling. Prior to sampling, a metal bellows pump was used to purge the bag of the helium, fill the bag with approximately 60 litres of ambient air, then purge the bag again. The 50-60 litre ambient air sample for analysis was collected by using the metal bellows pump with a Teflon sample line (~ 1.2 m long) extended out of the driver's side of the mobile laboratory for periods of 5-10 minutes. The samples were transported back to the laboratory for analysis. These roadway samples were collected mainly from I-270, I-40, Olive Road, Manchester Road and Babler Park. Detailed analytical results are contained in Appendix D.

The carbon monoxide to acetylene ratios were computed for each sample collected. The arithmetic mean of the ratio, 68.5, (Table 6) is similar to the carbon monoxide to acetylene ratio (63.4 ± 6.1) computed for automobile emissions in the Lincoln Tunnel by EPA researchers (5).

TABLE 6. CARBON MONOXIDE TO ACETYLENE RATIOS OF ROADWAY SAMPLES

Location	Date	Ratio of CO to C_2H_2
Manchester Road	9/22/76	70
I-40	9/22/76	78
I-270	9/22/76	60
N on I-270 (I-40 to Olive)*	9/27/76	(41)
W on Manchester	9/27/76	55
W on Olive	9/27/76	76
N on I-270 Olive to Page	9/27/76	83
W on Manchester (I-270 to Weidman Road)	10/29/76	60
W on Manchester Weidman Road to Ries Rd.	10/29/76	61
S on I-270 (Manchester to I-44)	10/29/76	67
N on I-270 (I-44 to Manchester)	10/29/76	75
		$\overline{X}$ = 68.5 S_x = 9.35
Babler Park**	9/22/76	96
Olive to Eatherton (west of airport)**	9/22/76	61

* Extremely high acetylene - not used in determining $\overline{X}$ and S_x

**Rural Samples

In order to ascertain the quality of data obtained from ambient air samples stored in Teflon bags over a period of time, the EPA Task Coordinator requested that some of the roadway samples be analyzed on the day collected and again 48 and 168 hours later. Table 7 shows samples collected from Manchester Road, I-40 and I-270 at the requested times.

5.2 ETHYLENE STUDIES

Ethylene studies were carried out at RAMS stations 101 and 124 on 20, 22, 28 and 31 October 1976 and 1 and 4 November 1976 because of periodic abnormally high concentrations of that compound found in these stations during the summer intensive. Ethylene was of particular interest because of its use with the ozone analyzers at the RAMS stations. For these studies, the ambient air samples were collected in 100 litre Teflon bags and in 8 litre stainless steel tanks. The samples were taken from the following locations on various days:

A. From RAMS station bag box with a sample taken outside simultaneously, 10-17 meters upwind and 2-3 meters above the ground using a metal bellows pump.

B. Inside the station between the pump box and bag box.

C. From the outlet of the center most blower of the pump box.

D. From the outlet of the vacuum pump in pump box.

The bags and tanks were immediately transported back to the laboratory and analyzed on the phenyl isocyanate column of the Perkin Elmer Model 900 gas chromatograph for C_2-C_5 hydrocarbons. Detailed analytical results are contained in Appendix D.

5.3 SPECIAL AUDITS

At the request of the EPA Task Coordinator, the cylinders MM11435, MM11437, MM11436 (from Scott-Marrin) and cylinder number FF3753 (from AIRCO Industrial Co.) were analyzed for CO, THC and CH_4 and RSG-80-4802 and RSG-80-7384 (from AIRCO Industrial Co.) for isobutane and normal hexane respectively. The audits were done in the following manner.

TABLE 7. STORAGE OF ROADSIDE SAMPLES IN TEFLON BAGS*

	MANCHESTER ROAD			INTERSTATE 40		INTERSTATE I-270		
	†C9/22/76 §A9/22/76	A9/24/76	A9/28/76	A9/22/76	A9/24/76	A9/22/76	A9/24/76	A9/28/76
Dura Pak								
C_2H_6	22.3	22.2	24.0	18.9	19.1	42.0	47.1	44.9
C_2H_4	157.1	148.6	158.5	127.3	121.0	253.0	280.1	254.4
C_3H_8	27.6	26.7	29.0	14.4	14.2	54.8	61.5	56.8
C_2H_2	111.5	99.5	105.4	83.1	78.0	190.1	208.2	185.0
$IsoC_4H_{10}$	15.2	14.5	15.8	11.3	11.1	19.8	24.2	22.0
$N\text{-}C_4H_{10}$	91.0	88.0	94.0	68.0	66.0	131.0	149.0	137.0
C_3H_6	73.7	69.8	74.2	60.3	57.3	112.7	125.0	113.5
$IsoC_5H_{12}$	125.0	119.0	130.0	84.0	81.0	172.0	191.0	179.0
$N\text{-}C_5H_{12}$	68.0	64.0	72.0	41.0	38.0	86.0	85.0	94.0
Squalane								
$N\text{-}C_6H_{14}$	46.0	41.0		64.0	27.0	38.0	87.0	
$N\text{-}C_7H_{16}$	15.0	15.0		32.0	14.0	51.0	28.0	
Toluene	72.0	71.0		165.0	67.0	239.0	140.0	
$N\text{-}C_8H_{18}$	12.0	14.0		16.0	12.0	45.0	25.0	
$E\text{-}C_6H_5$	30.0	36.0		68.0	37.0	107.0	66.0	
M-XYL	77.0	93.0		136.0	90.0	277.0	131.0	
O-XYL	30.0	36.0		65.0	32.0	91.0	56.0	
$N\text{-}C_9H_{20}$	4.0	4.0		4.0	1.0	21.0	10.0	
$N\text{-}P\text{-}C_6H_5$	5.0	8.0		6.0	2.0	18.0	10.0	
$N\text{-}C_{10}H_{22}$	16.0	9.0			5.0	41.0	25.0	

* Concentration in ppbC

† C - Collected

§ A - Analyzed

5.3.1 Total Hydrocarbon, Methane and Carbon Monoxide Audits

A five point calibration (Figure 11) was performed on the Beckman 6800 as described in Appendix A. The tanks to be audited were analyzed on the gas chromatograph and their concentrations determined from the 5-point calibration curve.

The results of the audit on 10/21/76 are shown in Tables 8 and 9.

TABLE 8. CARBON MONOXIDE AUDITS

Tank #	Manufacturer's Conc. in ppm	Rockwell Conc. in ppm	% Difference Rockwell vs. Manufacturer	EPA Conc. in ppm	% Difference Rockwell vs. EPA
MM11435	15.35	16.24	5.5	15.56	4.2
MM11436	8.00	8.31	3.7	8.17	1.7
MM11437	5.02	5.23	4.0	5.16	1.3
*FF3753		21.62		20.32	6.0
L-2359	5.06	5.33	5.1	5.29	0.7
L-1749	5.11			5.34	

*Tank prepared by EPA at RTP

TABLE 9. METHANE AUDITS

Tank #	Manufacturer's Conc. in ppm	Rockwell Conc. in ppm	% Difference Rockwell vs. Manufacturer	EPA Conc. in ppm	% Difference Rockwell vs. EPA
MM11435	8.04	7.81	2.9	8.35	6.5
MM11436	4.98	4.83	3.0	5.23	7.6
MM11437	2.02	1.95	3.5	2.08	6.3
*FF3753		5.85		6.33	7.6
L-1749	1.99	1.81	9.0	2.09	13.4
L-2359	1.95	1.82	6.7	2.20	17.3

*Tank prepared by EPA at RTP

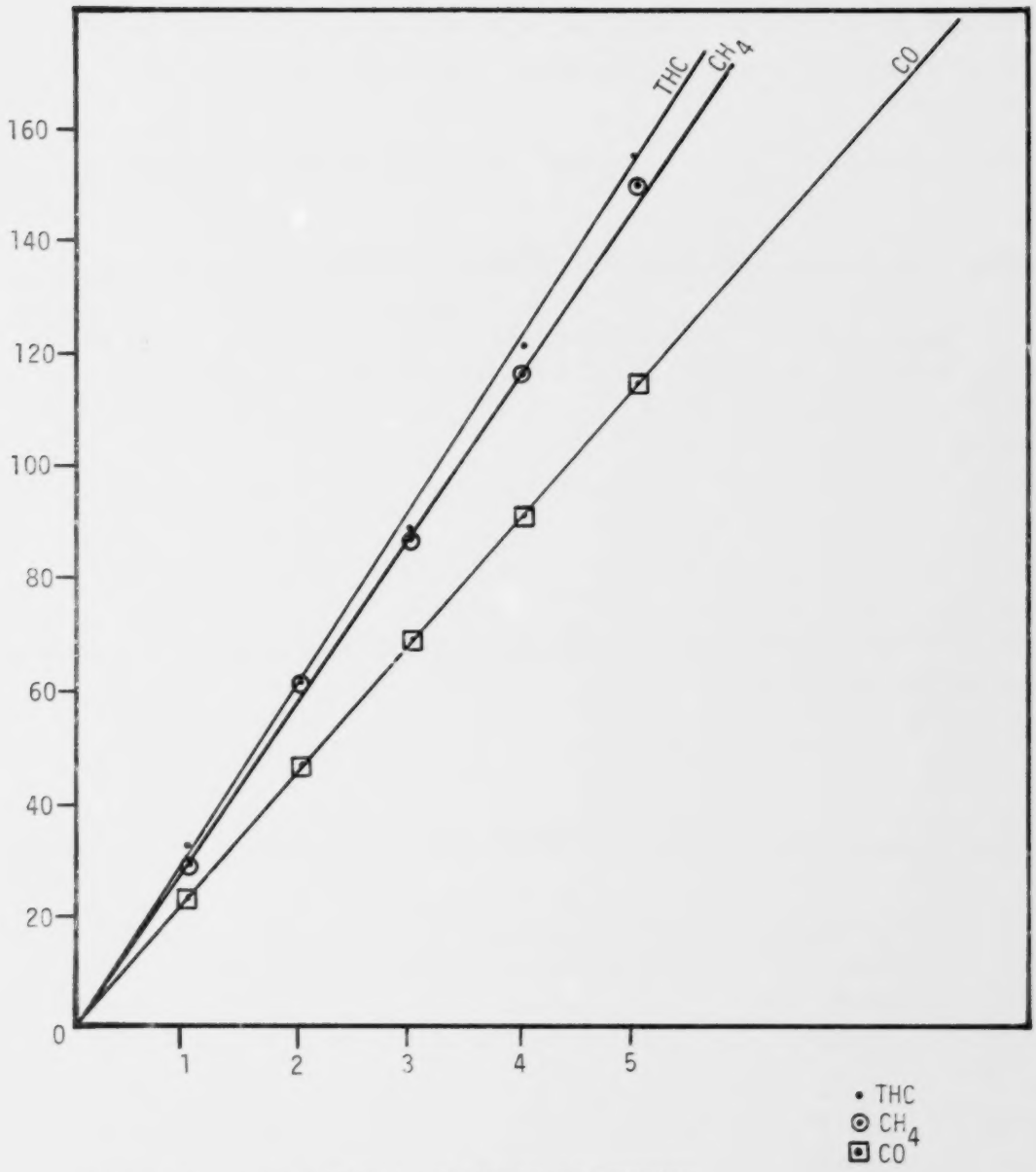

FIGURE 11. FIVE POINT CALIBRATION OF BECKMAN MODEL 6800 GAS CHROMATOGRAPH

5.3.2 Isobutane, Normal Hexane and Synthetic Bag Mixture Audits

Audits were performed on AIRCO cylinders RGS-80-7384 and RGS-80-4802 containing isobutane and normal hexane respectively in nitrogen and on a synthetic mixture of carbon monocide and methane in ultrapure air. In order to perform these audits, primary standards were prepared of I-C_4H_{10} and N-C_6H_{14} as described in Appendix B and a 5-point calibration was performed to facilitate the analysis of the synthetic bag mixture of CO and CH_4 which was prepared by the EPA Task Coordinator. The results are given in Table 10.

TABLE 10. ISOBUTANE, N-HEXANE AND SPECIAL BAG AUDITS

	AIRCO RGS-80-7384 Isobutane Conc. in ppm	AIRCO RGS-80-4802 Hexane Conc. in ppm
Manufacturer	57.0	50.0
Rockwell	62.1	36.5
EPA	58.4	47.0

The results of the special bag samples are:

	Measured	Value of EPA Std.
CH_4	4.5	4.59
CO	8.9	9.32

5.4 SPECIAL STUDIES AT RAMS 103 AND 107

Special studies were conducted at RAMS stations 103 and 107 in order to compare concentrations of compounds collected simultaneously in Teflon bags and stainless steel tanks; determine contamination at stations by collecting samples upwind; and to ascertain the accuracy of the data obtained from the gas chromatography laboratory. The samples were analyzed using the Dura Pak Column.

The bag and tank samples were collected by the same methods described in sections 4.2.1 and 4.1 respectively. The actual collection time varied from sample to sample, but bag and tank samples that were collected simultaneously

were collected over the same time interval. Tank samples were collected upwind of the stations.

Table 11 shows the results of replicate analyses of the samples, a comparisons of duplicate bag samples, and a comparison of station and upwind samples.

5.5 DATA VALIDATION, INTERPRETATION AND DISTRIBUTION

Each chromatogram of ambient air samples collected for the roadway, ethylene and special studies at RAMS 103 and 107 was visually analyzed by the EPA Task Coordinator and laboratory personnel jointly. The validated data on one copy of a 6800 foot, 9 track, 800 BPI, odd parity magnetic data tape, along with 2 copies of the printout were given to the EPA Task Coordinator. These data contain the sums of the paraffins, olefins, aromatics and total non-methane hydrocarbons per sample and are furnished in Appendix D of this text.

TABLE 11. QUANTITATIVE STUDIES AT RAMS 103 and 107

A. Reproducibility of Analyses

RAMS 103
Sample 103-1
Collection Time and Date: 7:15 - 9:05, November 24, 1976
Dura Pak Column. Concentrations in ppbC

Compound	First Analysis	Repeat Analysis	Duplicate Analysis	Average	Standard Deviation
C_2H_6	20.0	19.7	20.2	20.0	0.25
C_2H_4	48.7	48.3	49.6	48.9	0.67
C_3H_8	56.4	55.4	57.3	56.4	0.95
C_2H_2	29.5	26.6	28.4	28.2	1.46
$I\text{-}C_4H_{10}$	16.1	16.6	17.0	16.6	0.45
$N\text{-}C_4H_{10}$	53.1	54.5	55.2	54.3	1.07
C_3H_6	9.6	11.3	12.8	11.2	1.60
$I\text{-}C_5H_{12}$	43.7	44.8	45.5	44.7	0.90
$N\text{-}C_5H_{12}$	15.1	17.2	15.7	16.0	1.08

RAMS 107
Sample 107-1
Collection Time and Date: 7:22 - 9:12, November 30, 1976
Dura Pak Column. Concentrations in ppbC

Compound	First Analysis	Repeat Analysis	Duplicate Analysis	Average	Standard Deviation
C_2H_6	14.7	14.5	14.8	14.7	0.17
C_2H_4	47.3	46.9	47.6	47.3	0.30
C_3H_8	12.2	11.7	12.1	12.0	0.29
C_2H_2	37.3	38.8	43.1	39.7	3.01
$I\text{-}C_4H_{10}$	9.2	8.9	9.2	9.1	0.17
$N\text{-}C_4H_{10}$	41.4	40.8	42.3	41.5	0.75
C_3H_6	13.8	12.9	14.2	13.7	0.71
$I\text{-}C_5H_{12}$	40.5	40.6	40.6	40.6	0.06
$N\text{-}C_5H_{12}$	16.2	15.7	18.3	16.8	1.40

(continued)

TABLE 11 (continued)

B. Duplication of Samples

RAMS 107
Samples 107-1, 107-2
Collection Time and Date: 7:22 - 9:12, November 24, 1976
Dura Pak Column. Concentrations in ppbC

Compound	Bag #1	Bag #2	Average	Standard Deviation
C_2H_6	29.3	29.8	29.6	0.35
C_2H_4	76.2	74.8	75.5	0.99
C_3H_8	25.3	25.7	25.5	0.28
C_2H_2	72.3	72.6	72.5	0.21
$I\text{-}C_4H_{10}$	23.5	20.6	22.1	2.05
$N\text{-}C_4H_{10}$	94.0	90.4	94.2	2.54
C_3H_6	27.5	28.4	28.0	0.64
$I\text{-}C_5H_{12}$	84.9	82.3	83.6	1.83
$N\text{-}C_5H_{12}$	35.2	34.9	35.1	0.21

RAMS 107
Samples 107-1, 107-2
Collection Time and Date: 7:22 - 9:12, November 30, 1976
Dura Pak Column. Concentrations in ppbC

Compound	Bag #1	Bag #2	Average	Standard Deviation
C_2H_6	14.8	14.7	14.8	0.07
C_2H_4	47.3	56.1	51.7	6.22
C_3H_8	12.2	12.9	12.6	0.49
C_2H_2	37.3	38.1	37.7	0.56
$I\text{-}C_4H_{10}$	9.2	8.8	9.0	0.28
$N\text{-}C_4H_{10}$	41.4	41.1	41.3	0.21
C_3H_6	13.8	13.4	13.6	0.28
$I\text{-}C_5H_{12}$	40.6	40.1	40.4	0.35
$N\text{-}C_5H_{12}$	16.2	15.9	16.1	0.21

(continued)

TABLE 11 (continued)

C. Comparison of Upwind and Station Data

RAMS 103
Samples 103-1 (average), 103 Tank
Collection Time and Date: 7:15 - 9:05, November 23, 1976
Upwind Sample Collected in Stainless Steel Tank
Dura Pak Column. Concentrations in ppbC

Compound	Station Sample (average)	Upwind Sample (S.S. Tank)	% Δ
C_2H_6	20.0	19.5	2.5
C_2H_4	48.9	27.5	43.7
C_3H_8	56.4	52.3	7.3
C_2H_2	28.2	26.7	5.3
$I\text{-}C_4H_{10}$	16.6	14.1	15.1
$N\text{-}C_4H_{10}$	54.3	47.0	13.4
C_3H_6	11.2	11.1	0.9
$I\text{-}C_5H_{12}$	44.7	41.7	6.7
$N\text{-}C_5H_{12}$	16.0	15.0	6.2

RAMS 107
Samples 107-1 (average), 107 Tank
Collection Time and Date: 7:22 - 9:12, November 24 and 30, 1976
Upwind Sample Collected in Stainless Steel Tank
Dura Pak Column. Concentrations in ppbC

	11/24/76			11/30/76		
Compound	Station Sample	Upwind Sample	% Δ	Station Sample	Upwind Sample	% Δ
C_2H_6	29.6	30.2	-2.0	14.7	15.1	-2.7
C_2H_4	75.5	63.8	15.5	50.2	33.7	32.8
C_3H_8	25.5	25.1	1.6	12.3	12.4	-0.8
C_2H_2	72.5	76.2	-5.1	39.3	38.8	1.3
$I\text{-}C_4H_{10}$	22.1	19.4	12.2	9.0	10.7	-1.9
$N\text{-}C_4H_{10}$	94.2	85.2	9.6	41.4	42.3	-2.2
C_3H_6	28.0	27.3	2.5	13.6	12.3	9.6
$I\text{-}C_5H_{12}$	83.6	76.7	8.3	40.5	41.7	-3.0
$N\text{-}C_5H_{12}$	35.1	31.8	9.4	16.6	15.0	9.6

6.0 QUALITY CONTROL

To insure accurate results for all analyses done in the laboratory, quality control procedures were employed. The instruments were standardized using standard gases from Scott-Marrin for the Beckman 6800 and accurately prepared laboratory standards for the P.E. 900. (See Appendix B, Sec. 1.3) Records of area sizes and peak heights were maintained and checked daily, duplicate and repeat analyses were performed on the samples that were collected.

The first daily sample was analyzed three times in order to insure that the Perkin Elmer 900 was functioning properly. The first repeat analysis came directly after the original analysis, to provide a check on reproducibility of the machine; the second duplicate analyses were performed at the end of the day in order to ascertain whether the gas chromatograph maintained its stability. These duplications were usually within $\pm$ 5% of each other; if not, the samples were reanalyzed.

6.1 STANDARDS FOR BECKMAN 6800

Scott-Marrin gases were chosen as standards because of the good reputation of the company and the availability of the THC, CH_4, and CO gases in stable all-aluminum cylinders. EPA Quality Assurance Branch at the Research Triangle Park provided the calibrations used to determine the concentrations of the gases used as primary and secondary standards.

6.2 STANDARDS FOR PERKIN ELMER 900

Appendix B describes the methods employed to prepare standards. Propane was used on the phenyl isocyanate column and toluene on the squalane column in the P.E. 900 gas chromatograph. The gases were stored in an stainless steel cylinders in order to insure their stability.

6.3 DAILY STANDARDS

A tank containing laboratory air was used as a secondary standard.

Its composition was checked against the primary standards. The tank was refilled periodically because of the size of the cylinder and the volume of gas used per analysis, reanalyzed, then standardized against the primary standards.

Tables 12 and 13 show that from 20 July 1976 through 30 November 1976, the standard deviation of the analysis of propane, in two tank standards, were 0.08 ppbC and 1.07 ppbC with a standard error of 0.02 ppbC and 0.32 ppbC, respectively. For the same period, toluene exhibits a standard deviation of 0.58 ppbC and a standard error of 0.15 ppbC.

The comparison of areas of the standards was used as a quality control criterion as well as to detect the presence of leaks in the system. This approach provided a high level of confidence for the work done over this task order period.

TABLE 12. PROPANE STANDARD*

DATE	AREA
7/20/76	14.7193
7/22/76	13.7971
7/27/76	16.7500
7/29/76	16.7449
8/3/76	16.7033
8/4/76	17.0707
8/5/76	16.9472
8/10/76	17.1686
8/12/76	16.7462
8/17/76	16.5964
8/19/76	16.7571
	$\bar{X}$ = 16.36
	S_x = 1.07
	$S_{\bar{x}}$ = 0.32

DATE	AREA
8/24/76	2.2904
8/26/76	2.3351
8/31/76	2.3192
9/2/76	2.3775
9/22/76	2.3649
9/24/76	2.4480
9/27/76	2.3218
9/28/76	2.2637
10/20/76	2.1580
10/22/76	2.1924
10/28/76	2.2105
10/29/76	2.2111
11/1/76	2.1606
11/2/76	2.2017
11/3/76	2.1917
11/4/76	2.2104
11/8/76	2.2781
11/10/76	2.2583
11/12/76	2.2524
11/16/76	2.1953
11/18/76	2.2167
11/24/76	2.1489
11/30/76	2.2672
	$\bar{X}$ = 2.26
	S_x = 0.08
	$S_{\bar{x}}$ = 0.02

* These areas are directly proportional to the response factors and the concentrations. Areas in arbitrary units.

TABLE 13. TOLUENE STANDARD*

DATE	AREA
7/20/76	0.9344
7/22/76	1.0363
7/27/76	1.8308
8/3/76	1.4842
8/5/76	1.6171
8/12/76	0.9089
8/17/76	1.4664
8/19/76	0.8082
	$\bar{X}$ = 1.26
	S_x = 0.38
	$S_{\bar{x}}$ = 0.14

DATE	AREA
8/26/76	12.9900
8/31/76	13.2486
9/2/76	13.0400
9/22/76	13.0912
9/24/76	13.1302
9/27/76	13.2902
10/29/76	13.1078
11/8/76	12.6534
11/10/76	12.6560
11/12/76	12.5260
11/16/76	12.1836
11/18/76	13.0540
11/29/76	14.1280
11/30/76	14.3846
	$\bar{X}$ = 13.1100
	S_x = 0.58
	$S_{\bar{x}}$ = 0.15

* These areas are directly proportional to the response factors and the concentrations. Areas in arbitrary units.

7.0 DATA PROCESSING

Data generated by the RAPS Gas Chromatography Laboratory were processed and submitted to the RAPS Computer Data Bank, Research Triangle Park (RTP), North Carolina. Data processing from analysis to submission to the data bank was performed as described in the following sections.

7.1 DATA TABULATION

It was planned to perform approximately thirty-two analyses per week for up to sixty components. The data were initially recorded in the form of strip chart chromatograms, punched tape and/or teletype printouts. Next, the data were given a first quality review by visiually inspecting the data for general chromatographic form. Quantitative values for each component were then established. Following review and approval, the data were tabulated on a special preprinted form for keypunching.

7.2 KEYPUNCHING AND PROCESSING

At the end of the analysis period, the data forms were presented to the EPA Task Coordinator for review and approval and subsequently keypunched and keypunch validated. Keypunching errors were corrected by computer operators at the RAMS Computer Facility.

Data processing entailed checking the cards for index number consistency, as provided for by the form, and then producing a triple copy printout of labelling information: the name, code number, concentration (PPB), ratio relative to CO, and flags if the concentration or ratio was outside an upper and lower set of limits provided by EPA. Four quantities aggregated by the software were treated as components in all respects: sum of nonmethane paraffins, olefins, aromatics, and nonmethane hydrocarbons. Validation of the data was carried out by visual inspection and comparison of the data with the chromatogram and original tabulated data. Also, special attention was directed to flagged data for validity and proper annotation.

Upon completion of data validation, three copies of a 600 foot, 9 track, 800 BPI, odd-parity magnetic data tape were prepared. One copy was sent to RTP, along with a copy of the printout. The other copy of the tape and a printout was delivered to the EPA Task Order Coordinator (St. Louis) and a third copy of the printout and tape retained by the RAMS Central Computer Facility.

LITERATURE CITED

1. Mindrup, R. F., RAPS Final Report, Task Order 53, pg. 5-10.

2. Seeger, G. and Hern, D., RAPS Final Report, Task Order 103, pg. 20-30.

3. McReynolds, W. O., Gas Chromatograph Retention Data, pg. 22-26, 154-155.

4. Ettre, L. S., Open Tubular Columns, Perkin Elmer 1973, pg. 32-33.

5. Lonneman, et al, Environmental Science and Technology, Vl. 8, pg. 231.

APPENDIX A

OPERATION OF BECKMAN 6800 GAS CHROMATOGRAPH

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A.0 TOTAL HYDROCARCONS, CARBON MONOXIDE AND METHANE ANALYSES

Analyses of CO, THC and CH_4 were done on a Beckman Model 6800 Gas Chromatograph in the following manner:

The recorder was turned on, set at 10 mv range and zeroed with the zero volt button. The auto-zero switch was actuated in order to zero the electrometer of the chromatograph. The pump on the back of the chromatograph was turned on and a sample bag was connected to commence analyses.

To analyze total hydrocarbons, the attenuation was normally set at 4 and the range at 10 and the valve B toggle switch was actuated for approximately 15-20 seconds. The recorder was allowed to return to zero, aided with the auto-zero toggle switch. The attenuation was changed from 4 to 1 for the methane and carbon monoxide analyses and the valve A toggle switch actuated for 45 seconds.

A.1 REPRODUCIBILITY OF THE BECKMAN 6800

Reproducibility of the results of the analyses of THC, CH_4 and CO was checked by running duplicate analyses; that is, the first sample and the standard were rerun after the analysis of all other samples. During the course of this task order, these duplicates agreed closely with the initial analysis ($\pm$5%).

A.2 LINEARITY OF DETECTOR RESPONSE

Five point calibrations were carried out in duplicate to insure that the detector response was linear with respect to sample concentration. The tests were performed for THC, CH_4 and CO. These checks were determined from synthetic bag mixtures prepared in the laboratory. The procedure was as follows:

Five bags were prepared. The bags were labeled and filled with 100 liters of zero air using a mass flow meter. The appropriate amounts of CH_4 and CO were injected into each bag using a gas-tight calibrated syringe and allowed to diffuse throughout the bag. The bags were then analyzed. The make-up of the mixtures is shown below:

BAG #	ZERO AIR	CH_4	CO	CONC.
1	100 litres	0.1 ml	0.1 ml	1 ppm
2	100 litres	0.2 ml	0.2 ml	2 ppm
3	100 litres	0.3 ml	0.3 ml	3 ppm
4	100 litres	0.4 ml	0.4 ml	4 ppm
5	100 litres	0.5 ml	0.5 ml	5 ppm

A.3 PRIMARY STANDARD

A cylinder containing small amounts of methane and carbon monoxide in air (Scott-Marrin L 1749) was analyzed by the EPA at Research Triangle Park, North Carolina. Its concentrations was computed to be 5.33 ppm CO and 1.99 ppm CH_4. This cylinder served as the primary standard for the Beckman 6800 and was used to calibrate other tanks.

A.4 SECONDARY STANDARDS

Two other cylinders (Scott-Marrin L 2327 and L 2359) served as secondary standards for the Beckman 6800 during this task order period. When analyzed against the primary standard Scott-Marrin L 1749, their concentrations were computed to be 5.28 ppm CO, 4.38 ppm CH_4 and THC for Scott L 2327 and 5.29 ppm CO and ppm CH_4 and 2.20 ppm CH_4 and THC for Scott L 2349. The secondary standards were checked against the primary ones once a month.

A.5 CALCULATIONS

Calculations of the concentrations of THC, CH_4 and CO in various samples are straight forward and were done by hand. When analyses were to be performed, the secondary standard was analyzed; that is, its peak height was measured. Since its concentration was known, it was possible to compute the concentration of unknown once its peak height was measured:

$$\frac{\text{Standard concentration in ppm}}{\text{Peak height of standard in mm}} \times \text{peak height of unknown in mm} = \text{concentration of unknown}$$

Initially, a sample of standard gas was injected into a Teflon bag, then analyzed on the Beckman 6800. It was observed that the peak height varied as much as 42.6% for THC, 9.7% for CH_4 and 58% for CO. These variations were unacceptable; therefore, another method was devised by which the standard gas was passed directly into the Beckman 6800. With this procedure, maximum peak height variation for THC was 8.4%, CH_4 was 14.9%, and CO was 17.9%. The standard deviations were computed to be 4.88 mm (3.8%) for THC, 7.25 mm (6.5%) for CH_4 and 9.89 mm (9.2%) for CO as shown in Table A-1.

TABLE A-1. TANK L-2327 - TANK STANDARD FOR 6800

DATE	THC	CH_4	CO
6/23/76	129.5*	105.0	102.0
6/28/76	127.0	103.5	100.5
7/06/76	127.0	106.5	92.0
7/08/76	142.5	104.0	98.5
7/13/76	132.0	102.0	85.5
7/15/76	115.5	97.0	86.8
7/20/76	130.0	106.0	103.8
7/22/76	129.5	112.0	110.7
7/27/76	122.6	117.3	117.0
7/29/76 am	124.8	106.6	96.7
7/29/76 pm	124.7	121.8	122.4
8/03/76 am	126.4	115.1	112.8
8/03/76 pm	129.1	115.0	109.0
8/03/76	125.8	116.5	114.6
8/05/76	126.4	116.9	116.5
8/10/76 am	132.9	102.3	106.5
8/10/76 pm	130.1	112.5	106.9
8/12/76 am	128.4	120.9	121.0
8/12/76 pm	127.1	118.3	119.1
8/24/76	127.0	117.2	113.3
8/26/76 am	125.1	117.5	114.7
8/26/76 pm	125.1	118.7	115.8
	$\bar{X}$ = 127.7	$\bar{X}$ = 111.48	$\bar{X}$ = 108.00
	S_x = 4.88	S_x = 7.25	S_x = 9.89
	$S_{\bar{x}}$ = 1.04	$S_{\bar{x}}$ = 1.54	$S_{\bar{x}}$ = 2.11

* Response in mm

APPENDIX B

OPERATION OF THE PERKIN ELMER 900 GAS CHROMATOGRAPH

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B.0 C_2 - C_{10} HYDROCARBON ANALYSIS

The RAMS bag samples were analyzed for C_2-C_{10} hydrocarbons on the PE 900 gas chromatograph. The ambient air samples were analyzed and the concentrations of the compounds determined by comparing the samples to the standard. One sample was analyzed in duplicate and in some cases triplicate to insure the reproducibility of the entire set of samples and the precision and accuracy of the gas chromatograph.

B.1 GENERAL PROCEDURES

The hydrogen and air sources were turned on and the flame ionization detectors lighted. The oven was cooled from 90°C (overnight and weekend temperature) to 25°C by turning on the liquid nitrogen. The recorders were turned on, checked for positive response, then zeroed; the vacuum line was turned on. Directives of identification and sampling time were entered on the teletype to the PEP-1 integrator.

The stainless steel concentration trap was placed in a Dewar flask which contained liquid oxygen. The appropriate vacuum line was connected to the vacuum source and the bag or tank connected to the inlet line. The vacuum source was opened and a small sample was drawn through the inlet line to purge the line of any air from a previous sample. The inlet valve was switched to the trapping mode and a measured volume of the sample was cold-trapped into the liquid oxygen cooled concentration trap.

After the sample was trapped, the ready light on the PEP-1 interface was actuated, the valve switched to the injection mode and a Dewar flask of hot water applied to the concentration trap. The "ready light" on the gas chromatograph was immediately pressed to initiate the temperature programming. The chromatograph was programmed to hold 25°C for 8 minutes. The temperature was then raised at a rate of 2°C per minute to 90°C, where it was held for the remainder of the run. The valve was returned from the injection mode to the backflush (neutral) position after 2 minutes. The analyses times were 10

minutes for the phenyl isocyanate column (C_2-C_5) and 55 minutes for the squalane column (C_5-C_{10}).

Upon completion of the analyses, the PEP-1 integrator tabulated the area measured, the concentration and the identification of peaks. The reset button on the gas chromatograph was pressed and the above procedure was repeated. The analyses and turnaround time for trapping sample, analysis and computer printout times for C_2-C_5 were approximately 0.5 hours on the phenyl isocyanate column and 1.35 hours for C_5-C_{10} on the squalane column. The files of the memory bank of the PEP-1 computer were normally erased at the end of the working day.

B.2 REPRODUCIBILITY OF THE PHENYL ISOCYANATE COLUMN

To ascertain and maintain reproducibility of this column, the propane standard and triplicate sample analyses were used as indicators. Any major change in the area size of the propane standard or major deviation from the concentrations of nine compounds analyzed on the column signaled problems in the system. The magnetic tapes and the computer printouts demonstrate the reproducibility of the triplicate analyses done on the first daily bag samples. The reproducibility of the daily duplicate and triplicate analyses were generally within $\pm$ 5%.

B.3 LINEARITY OF DETECTOR RESPONSE OF PHENYL ISOCYANATE COLUMN

Five point calibrations were carried out on the P.E. 900 is insure that the detector response was linear with respect to sample concentration. Five mil (0.005 inch) Teflon bags were filled with ultrapure air and injected with accurately measured quantities of propane and toluene. After allowing half an hour for diffusion, samples were withdrawn from this bag ("A") and injected into five other bags, each of which had been filled with 50 l of ultrapure air according to the schedule shown on the following page:

Bag #	Zero Air	C_3H_8 (99% purity)	Conc.	Toluene (99% purity)	Conc.
A	50 liters	5 ml of propane	100 ppm	0.05 ml toluene	226.9 ppm
1	50 litres	1 ml from Bag A	6 ppbC	1 ml from Bag A	31.9 ppbC
2	50 litres	2 ml from Bag A	12 ppbC	2 ml from Bag A	63.8 ppbC
3	50 litres	3 ml from Bag A	18 ppbC	3 ml from Bag A	95.7 ppbC
4	50 litres	4 ml from Bag A	24 ppbC	4 ml from Bag A	127.6 ppbC
5	50 litres	5 ml from Bag A	30 ppbC	5 ml from Bag A	159.5 ppbC

The bags were analyzed in descending order, then reanalyzed in the same order for duplicate analyses. Figures B-1 and B-2 and Tables B-1 and B-2 are examples of the 5 point calibrations of propane and toluene respectively.

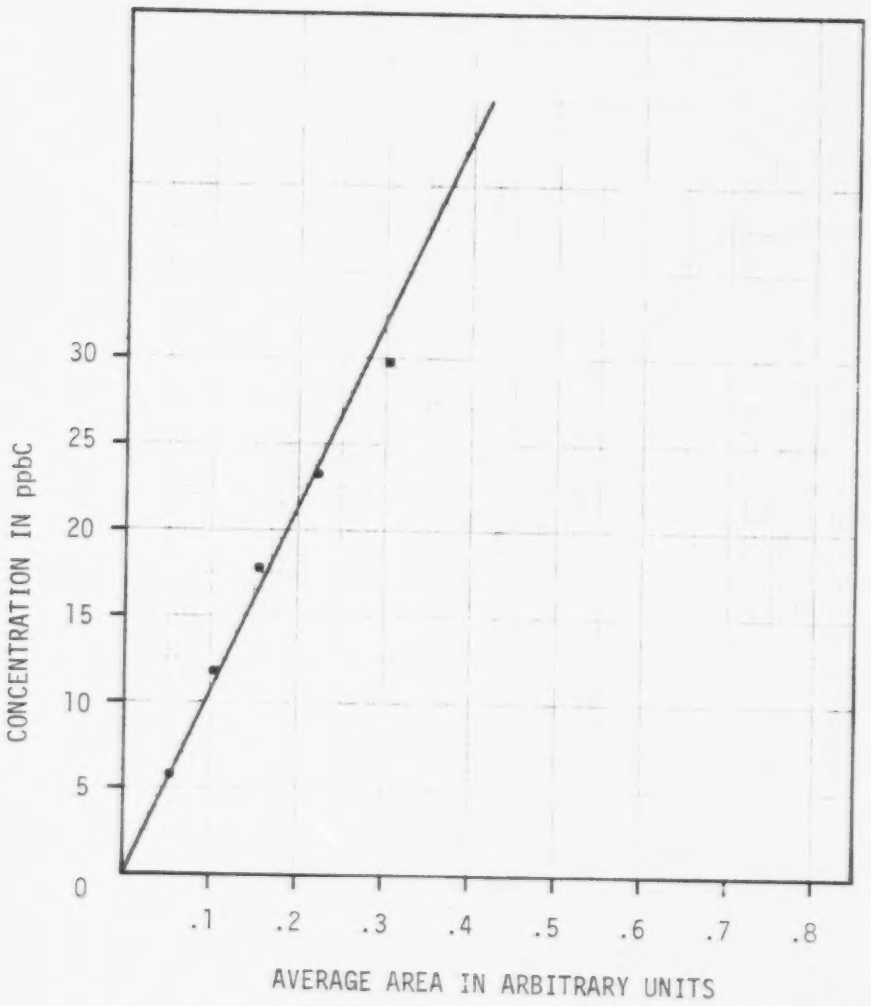

FIGURE B-1. FIVE POINT CALIBRATION OF PROPANE ON PERKIN ELMER 900 GAS CHROMATOGRAPH

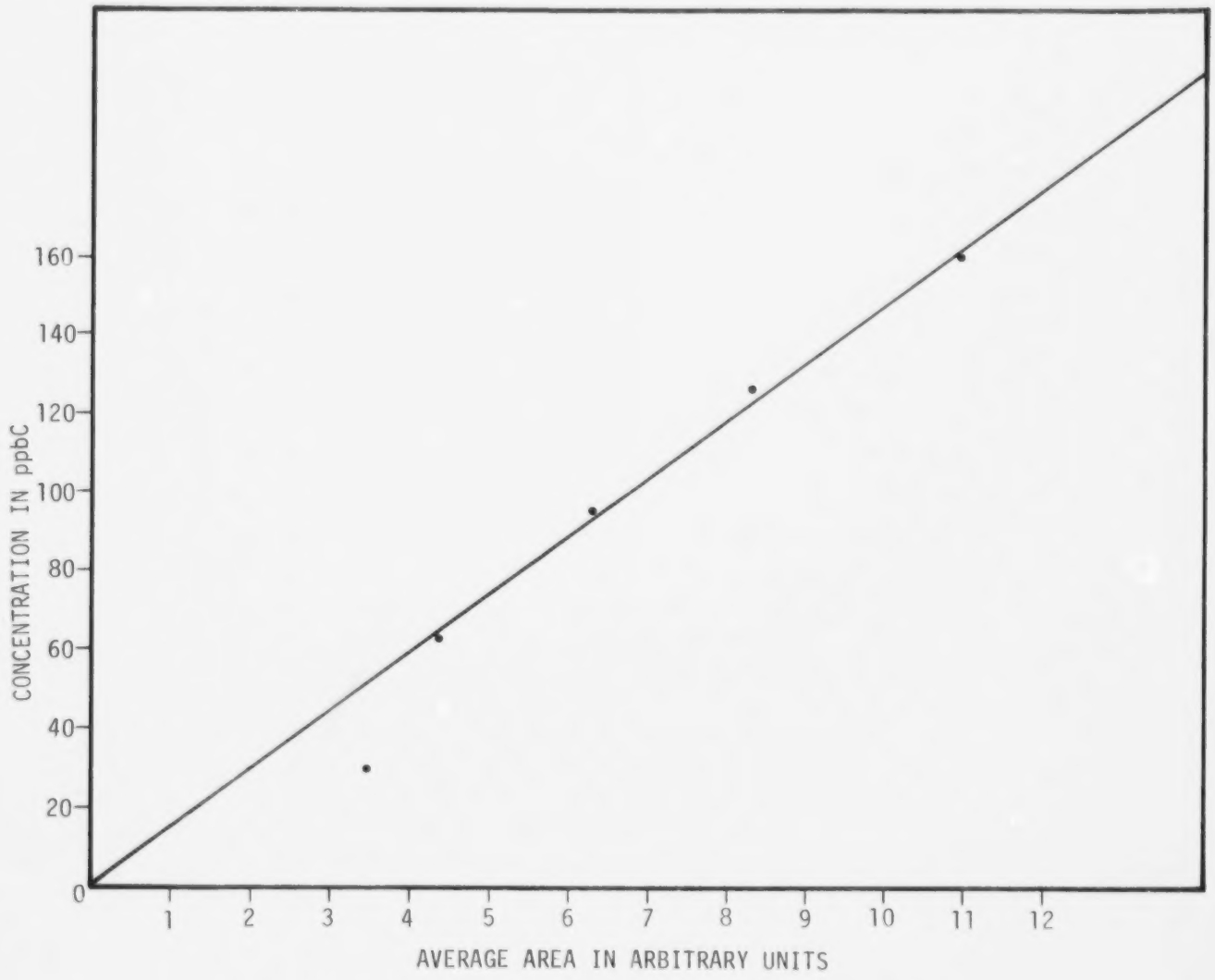

FIGURE B-2. FIVE POINT CALIBRATION OF TOLUENE ON PERKIN ELMER 900 GAS CHROMATOGRAPH

TABLE B-1. FIVE POINT CALIBRATION OF PROPANE

Bag A: 5.0 ml gas 50L of ultrapure air

Bag 1 to 5: 50 litres of ultrapure air each

Number	Amount Injected From Bag A	AREA Run - 1	Run - 2	Average	Conc.
1	1.0 ml	0.0642	0.0641	0.0641	6 ppbC
2	2.0 ml	0.1068	0.1061	0.1064	12 ppbC
3	3.0 ml	0.1631	0.1652	0.1641	18 ppbC
4	4.0 ml	0.2288	0.2297	0.2292	24 ppbC
5	5.0 ml	0.3080	0.3082	0.3081	30 ppbC

TABLE B-2. FIVE POINT CALIBRATION OF TOLUENE

Bag A: 0.0500 ml liquid 50L of ultrapure air

Bag 1 to 5: 50 litres of ultrapure air each

Number	Amount Injected From Bag A	AREA Run - 1	Run - 2	Average	Conc.
1	1.0 ml	3.5380	--	3.5380	31.9 ppbC
2	2.0 ml	4.4350	4.4036	4.4193	63.8 ppbC
3	3.0 ml	6.6937	6.4601	6.5769	95.7 ppbC
4	4.0 ml	8.5107	8.1254	8.3181	127.6 ppbC
5	5.0 ml	10.9798	10.7468	10.8633	159.5 ppbC

B.4 PEP-1 COMPUTER CALCULATIONS FOR P.E. 900

The PEP-1 computer was programmed in such a manner that it could detect, file, store, compute the concentration of selected compounds and print out pertinent data of samples that were analyzed on the P.E. 900.

In order to accurately compute the concentrations of the label compounds, the following information was input to the computer:

1) reference peak(s)

2) relative retention times for all compounds

3) response factor for all compounds

4) response factor update

B.1.4.1 Reference Peak(s)

N-Butane and toluene were chosen as the reference peaks for the phenyl isocyanate and squalane columns respectively because both compounds occur abundantly in ambient air samples and no large peaks appear nearby, making identification easy. When writing the programs for the phenyl isocyanate and squalane columns, n-butane was assigned a reference number of one (1) and toluene was assigned a reference number of five (5). Along with the reference numbers, time spans for the elutions of the two compounds were provided.

B.4.2 Relative Retention Times

Relative retention times may be obtained two ways: manual computation or the PEP-1 system. The G. C. Laboratory employs both methods; the procedure and results of both are identical. As an example, the calculation of RRT of C_2H_6 is as follows:

X = Relative retention time of n-butane = 1.0.

T = The elution time in minutes of n-butane = 2.5 minutes.

X^1 = The unknown relative retention time of C_2H_6.

T^1 = The known elution time of the C_2H_6 = 0.87 minutes.

$$\frac{X}{T} = \frac{X^1}{T^1}$$

$$\frac{1}{2.5} \times .87 = X^1$$

$$X^1 = .348$$

It should be noted here that once the reference peak has been designated and its elution time standardized, the PEP-1 automatically assigned the relative retention times to all other compounds occurring in each sample. The same procedure was used for toluene.

B.4.3 Response Factor

To obtain response factors (RF) for hydrocarbons C_2 - C_{10} a primary standard was made up and analyzed in the laboratory. The PEP-1 was programmed in such a manner that only the areas of the selected compounds were computed. After manually calculating the concentrations of the hydrocarbons and obtaining the various areas from the computer, it was possible to calculate the response factors for each compound.

The PEP-1 used the following formula:

Area x response factor x 5 = concentration

To calculate the response factors of the hydrocarbons:

$$RF = \frac{\text{Concentration}}{\text{Area} \times 5}$$

Example: Toluene

$$RF = \frac{31.9}{2.0440 \times 5}$$

$$RF = 3.12$$

Response factors for all selected C_2 - C_{10} hydrocarbons were determined in the above fashion.

After all of the calculations are done and the computer has been properly programmed, the PEP-1 uses; area x response factor x 5 to compute the concentrations of unknowns against the concentration of a standard.

B.4.4 Response Factor Update

Once the concentration of the standard was calculated and an acceptable range (± 3%) for propane and ± 3% for toluene) for the area size of each compound had been established, the response factor update feature of the PEP-1 data system was used to correct the small changes that occur in the detector from day to day. The daily computed concentrations for the propane and toluene standards were compared to the calculated value for these standards; the relative change was fed to the computer and the response factor for each compound that is analyzed is multiplied by that factor. During this task order period, the detectors showed little or no change. The changes that occurred were random with a standard deviation of less than ± 3%.

B.5 CALCULATIONS USED TO DETERMINE STANDARD CONCENTRATIONS

The preparation of primary standards and the secondary standard was done at the same time. Only one secondary standard was needed because ambient air contains the propane and toluene that was used by the Gas Chromatography Laboratory on the phenyl isocyanate and squalane columns, respectively. The PEP-1 computer system uses the area x response factor x 5 method for computing the concentrations of compounds.

B.6 PRIMARY STANDARDS (Propane and Toluene) P.E. 900

The primary standards for the P.E. 900 were synthetically prepared in the laboratory by using the same reagents and equipment described in Section B.3 of this appendix. It should be noted here that only one dilution bag was used.

B.7 SECONDARY STANDARDS (Propane and Toluene) P.E. 900

Since the hydrocarbons to be analyzed occurred in laboratory air, secondary standards were prepared by simply storing a pressurized sample of ambient air in an 8 litre stainless steel tank, equipped with the appropriate valves. A sample of the secondary standard was then analyzed and the concentration of propane and toluene computed.

APPENDIX C

DATA FROM SUMMER AND FALL INTENSIVES

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C.0 INTRODUCTION

Appendix C contains data obtained from samplings at RAMS stations. The results are in table form in order to provide an overview of the data from RAMS stations. The arithmetic mean ($\overline{X}$) and standard deviation (S_x) were calculated for total hydrocarbon (THC), methane (CH_4), carbon monoxide (CO) and acetylene (C_2H_2) for each table so that comparisons could be made between and among the RAMS stations. Not all compounds are listed in these tables. The magnetic tape of data delivered to the EPA contains the concentration for all compounds as well as sums for olefins, paraffins, etc. The following marks and abbreviations were used: "Trace" indicates less than 1 ppbC in the squalane analyses, "BDL" below detection limits, "NM" not measurable (because of interference, etc.). All concentrations in the following tables are in ppbC and the time of samples is Central Daylight Time (CDT) from April 25 to October 30 and Central Standard Time (CST) after October 30.

Figure C-1 shows the header for that tape and lists the various compounds which are reported.

001TOTAL SULFUR
002HYDROGEN SULFIDE
003SULFUR DIOXIDE
004METHYL MERCAPTAN
005NITROGEN OXIDES (NOX)
006SULFUR HEXAFLUORIDE
007TRICHLORO-FLUORO METHANE
008DICHLORO-DIFLUORO METHANE
009TOTAL ORGANICS
010METHANE
011CARBON MONOXIDE
012ETHYLENE
013ETHANE
014ACETYLENE
015PROPANE
016PROPYLENE
017ISOBUTANE
018ISOBUTYLENE + BUTENE-1
019N-BUTANE
020T-2-BUTENE
021C-2-BUTENE
0223-M-1 BUTENE
0231SOPENTANE
024PENTENE-1
0252-M-1 BUTENE
026N-PENTANE
027T-2-PENTENE
028C-2-PENTENE
0292-M-2 BUTENE
0302,2-DM-BUTANE
031CYCLOPENTENE
0323-M-1-PENTENE + 4-M-1-PENTENE
0334-M-C-2-PENTENE
034CYCLOPENTANE
0352,3-DM-BUTANE + 4-M-T-2 PENTENE
0362-M-PENTANE
0372-M-1-PENTENE
0383-M-PENTANE + HEXENE-1 + 2-E-1-BUTENE
039T-3-HEXENE
0402-M-2-PENTENE + 3-M-CYCLOPENTANE
0413-M-C-2 PENTENE
042N-HEXANE
043T-2-HEXENE
044C-2-HEXENE
0453-M-T-2-PENTENE
046METHYLCYCLOPENTANE + 3,3-DM-1-PENTENE
047BENZENE
0482,4-DM-PENTENE
0492,2,3-TM-BUTANE
0502,4-DM-1-PENTENE
0511-METHYLCYCLOPENTENE + 2-M-C-3-HEXENE
0522,4-DM-2-PENTENE + 3-E-1-PENTENE + 3-M-1-HEXENE
0532-M-T-3-HEXENE + 5-M-1-HEXENE
054CYCLOHEXANE + 4-M-C-2-HEXENE

(continued)

FIGURE C-1. LISTING OF ALL COMPOUNDS RECORDED ON MAGNETIC TAPES

0554-M-1-HEXENE + 4-M-T-2-HEXENE
0563-M-2-E-1-BUTENE + 5-M-T-2-HEXENE
057CYCLOHEXENE
0582-M-HEXANE + 5-M-C-2-HEXENE
0592,3-DM-PENTANE + 1,1-DM-CYCLOPENTANE
0603-M-HEXANE
0611-C-3-DM-CYCLOPENTANE + 2-M-1-HEXANE
0621-T-3-DM-CYCLOPENTANE + 1-HEPTENE + 2-E-1-PENTANE
0633-E-PENTANE + 3-M-T-2-HEXENE
0642,2,4-TM-PENTANE + T-3-HEPTENE
065C-3-HEPTENE
0663-M-C-3-HEXENE + 2-M-2-HEXENE + 2-M-T-3-HEXENE
0673-E-2-PENTENE
068N-HEPTANE
0692,3-DM-2-PENTENE + C-2-HEPTENE
0701-C-2-DM-CYCLOPENTANE
071M-CYCLOHEXANE + 2,2-DM-HEXANE + 1,1,3-TM-CYCLOPENTANE
0724-M-CYCLOHEXENE
0732,5-DM-HEXANE
074ETHYLCYCLOPENTANE
0752,4-DM-HEXANE
0762,2,3-TM-PENTANE
0771-T-2-C-4-TM-CYCLOPENTANE
078TOLUENE
0792,3,4-TM-PENTANE
0802,3,3-TM-PENTANE
0812,3-DM-HEXANE + 2-M-3-E-PENTANE
0822-M-HEPTANE
0834-M-HEPTANE
0843,4-DM-HEXANE + 1-C-2-T-4-TM CYCLOPENTANE
0853-M-HEPTANE + 3-M-3-E-PENTANE
0862,2,5-TM-HEXANE + 1-C-2-C-4-TM CYCLOPENTANE
0871-T-4-DM-CYCLOHEXANE
0881-M-T-3-E-CYCLOPENTANE
0892,2,4-TM-HEXANE
090CYCLOHEPTANE + 1-M-1-E-CYCLOPENTANE
0911-T-2-DM-CYCLOHEXANE + 1-C-2-C-3-TM-CYCLOPENTANE
092N-OCTANE
0931-T-3-DM-CYCLOHEXANE
0942,4,4-TM-HEXANE
0952,3,5-TM-HEXANE
0962,2-DM-HEPTANE
0972,4-DM-HEPTANE + 2,2,3-TM-HEXANE
0982,2-DM-3-PENTANE + 2-M-4-E-HEXANE
0992,6-DM-HEPTANE + 1-C-2-DM-CYCLOHEXANE
100N-PROPYLCYCLOPENTANE
101ETHYLCYCLOHEXANE
1022,5-DM-HEPTANE + 3,5-DM-HEPTANE
103ETHYLBENZENE
1043,3-DM-HEPTANE
1052,3,3-TM-HEPTANE
106P-XYLENE
107M-XYLENE
1084-M-OCTANE

(continued)

FIGURE C-1 (continued)

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102M-M-OCTANE
103E-E-HEPTANE
113M-M-OCTANE
120O-XYLENE
132.2,4-TM-HEPTANE
142,2,5-TM-HEPTANE + 2,2,6-TM-HEPTANE
152,5,5ITM-HEPTANE + 2,4,4ITM-HEPTANE
116N-NONANE
117N-PROPYLBENZENE
182,2,3,3-TM-HEXANE
191-M-2-E-BENZENE
201,3,5-TM BENZENE
121TERT-BUTYLBENZENE
221,2,4-TM-BENZENE
123SEC-BUTYLBENZENE + ISOBUTYLBENZENE
124N-DECANE
251,2,3-TM-BENZENE + 1-M-4-ISOPROPYLBENZENE
126N-BUTYLBENZENE
127PARAFFINS
128OLEFINS
129AROMATICS
130TOTAL NON-METHANE HYDROCARBONS
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FIGURE C-1 (continued)

TABLE C-1. RAMS STATION 101

SUMMER INTENSIVE

	Mean	Standard Deviation
THC	3720 ppbC	494 ppbC
CH_4	2016 ppbC	262 ppbC
CO	1621 ppbC	634 ppbC
C_2H_2	19.8 ppbC	11 ppbC

Date	6/23/76 7-9	6/23/76 9-11	6/23/76 11-13	6/23/76 13-15	7/13/76 9-11	7/15/76 7-9	7/15/76 9-11
Dura Pak							
C_2H_6					8.7	8.0	5.9
C_2H_4					996.5	967.5	18.8
C_3H_8					22.8	8.2	5.3
C_2H_2					8.7	8.6	5.0
$IsoC_4H_{10}$					12.6	4.1	4.5
$N\text{-}C_4H_{10}$					62.6	17.7	17.3
C_3H_6					2.4	3.0	BDL*
$IsoC_5H_{12}$					55.0	22.0	14.0
$N\text{-}C_5H_{12}$					14.0	9.0	7.0
Beckman 6800							
THC	2690	2600	3550	2540	3850	3640	2730
CH_4	1960	1940	1900	1900	2060	2030	2090
CO	1520	1010	1050	1220	2210	1280	1460

* Below detection limits

(continued)

TABLE C-1 (continued)

Date	7/15/76 11-13	7/15/76 13-15	7/20/76 7-9	7/20/76 9-11	7/20/76 11-13	7/20/76 13-15	7/22/76 7-9
Dura Pak							
C_2H_6	5.3	4.1	8.4	8.0	4.9	4.5	12.6
C_2H_4	1055.6	12.7	1345.9	30.0	1253.4	11.7	1553.2
C_3H_8	6.0	3.4	10.4	9.7	5.2	4.1	16.7
C_2H_2	4.5	6.3	10.9	5.5	4.6	2.1	19.3
$IsoC_4H_{10}$	3.5	4.1	7.2	6.4	5.4	4.1	15.1
$N\text{-}C_4H_{10}$	12.6	15.6	32.7	24.5	32.3	21.3	72.9
C_3H_6	1.3	1.0	6.3	3.0	BDL*	BDL*	11.5
$IsoC_5H_{12}$	14.0	13.0	36.0	25.0	26.0	18.0	73.0
$N\text{-}C_5H_{12}$	7.0	4.6	18.0	8.0	8.0	6.0	28.5
Squalane							
$N\text{-}C_6H_{14}$			12				27
$N\text{-}C_7H_{16}$			5				9
Toluene			50				62
$N\text{-}C_8H_{18}$			15				5
$E\text{-}C_6H_5$			18				25
M-XYL			88				67
O-XYL			19				22
$N\text{-}C_9H_{20}$			40				2
$N\text{-}P\text{-}C_6H_5$			1				3
$N\text{-}C_{10}H_{22}$			189				5
Beckman 6800							
THC	3680	2470	3690	7950	3560	2270	3960
CH_4	1960	1870	1920	1800	1780	1720	1920
CO	730	700	1320	926	712	610	2120

* Below detection limits

(continued)

TABLE C-1 (continued)

Date	7/22/76 9-11	7/22/76 13-15	7/27/76 7-9	7/27/76 9-11	7/27/76 11-13	7/27/76 13-15	7/29/76 7-9
Dura Pak							
C_2H_6	9.4	5.8	14.5	10.4	12.3	8.7	11.3
C_2H_4	33.5	21.9	1240.8	30.1	1137.4	14.3	1044.0
C_3H_8	9.1	5.5	23.4	18.6	12.0	9.0	12.0
C_2H_2	10.8	4.2	17.3	11.9	11.2	8.5	12.4
$IsoC_4H_{10}$	6.6	6.2	13.8	12.4	5.0	4.4	4.4
$N\text{-}C_4H_{10}$	27.3	28.9	45.6	36.9	22.1	23.3	24.2
C_3H_6	3.6	BDL*	34.0	43.0	66.0	25.0	15.0
$IsoC_5H_{12}$	28.0	24.0	43.0	30.0	22.0	21.0	26.0
$N\text{-}C_5H_{12}$	19.0	10.0	17.0	11.0	10.0	6.0	9.9
Squalane							
$N\text{-}C_6H_{14}$			10				13
$N\text{-}C_7H_{16}$			4				2
Toluene			48				117
$N\text{-}C_8H_{18}$			3				4
$E\text{-}C_6H_5$			13				30
M-XYL			40				73
O-XYL			11				24
$N\text{-}C_9H_{20}$			2				3
$N\text{-}P\text{-}C_6H_5$			1				2
$N\text{-}C_{10}H_{22}$							3
Beckman 6800							
THC	2370	2520	4010	2600	4860	2260	3630
CH_4	1870	1800	1630	1480	2110	1710	2080
CO	1060	525	1130	796	758	781	1190

* Below detection limits

(continued)

TABLE C-1 (continued)

Date	7/29/76 9-11	7/29/76 11-13	7/29/76 13-15	8/3/76 7-9	8/3/76 9-11	8/3/76 11-13	8/3/76 13-15
Dura Pak							
C_2H_6	11.7	12.2	14.1	9.8	6.6	5.0	6.0
C_2H_4	26.9	1402.6	41.3	1345.6	22.9	1151.5	20.7
C_3H_8	16.5	19.2	20.8	17.7	11.4	7.2	8.6
C_2H_2	12.7	13.4	12.9	10.7	5.6	3.7	4.7
$IsoC_4H_{10}$	8.5	10.4	10.3	4.2	4.2	2.7	6.1
$N\text{-}C_4H_{10}$	43.3	63.6	53.0	22.7	15.1	10.6	22.2
C_3H_6	11.5	14.0	8.0	6.8	3.1	1.5	1.3
$IsoC_5H_{12}$	38.0	50.0	42.0	23.0	10.0	9.2	19.0
$N\text{-}C_5H_{12}$	15.0	18.0	18.0	12.0	5.0	4.3	9.0
Squalane							
$N\text{-}C_6H_{14}$				8			
$N\text{-}C_7H_{16}$				2			
Toluene				81			
$N\text{-}C_8H_{18}$				4			
$E\text{-}C_6H_5$				9			
M-XYL				24			
O-XYL				8			
$N\text{-}C_9H_{20}$				1			
$N\text{-}P\text{-}C_6H_5$				BDL*			
$N\text{-}C_{10}H_{22}$				2			
Beckman 6800							
THC	3320	2960	6440	4060	2470	3180	2240
CH_4	2000	1740	1710	2090	1920	1680	1720
CO	1250	1070	1120	1040	754	585	645

*Below detection limits

(continued)

TABLE C-1 (continued)

Date	8/5/76 7-9	8/5/76 9-11	8/5/76 11-13	8/5/76 13-15	8/12/76 7-9	8/12/76 9-11	8/12/76 11-13
Dura Pak							
C_2H_6	9.0	7.0	6.1	6.0	8.6	8.9	8.3
C_2H_4	1321.0	14.9	15.8	19.9	24.9	1864.0	43.8
C_3H_8	11.2	7.3	5.5	4.9	19.4	18.4	7.7
C_2H_2	14.4	8.3	6.5	6.2	29.7	10.3	7.4
$IsoC_4H_{10}$	8.2	5.0	6.7	5.1	14.0	14.0	5.5
$N\text{-}C_4H_{10}$	48.3	26.7	41.0	28.0	70.6	47.2	24.9
C_3H_6	5.1	2.5	1.0	1.1	7.3	3.4	1.8
$IsoC_5H_{12}$	49.0	29.0	30.0	25.0	54.0	30.0	23.0
$N\text{-}C_5H_{12}$	21.0	11.0	13.0	11.0	28.0	13.0	10.0
Squalane							
$N\text{-}C_6H_{14}$	9				23		
$N\text{-}C_7H_{16}$	3				7		
Toluene	32				73		
$N\text{-}C_8H_{18}$	2				8		
$E\text{-}C_6H_5$	9				55		
M-XYL	32				199		
O-XYL	12				47		
$N\text{-}C_9H_{20}$	1				8		
$N\text{-}P\text{-}C_6H_5$	1				3		
$N\text{-}C_{10}H_{22}$	3				20		
Beckman 6800							
THC	3810	2350	2300	2200	3110	3790	2390
CH_4	1820	1730	1720	1720	1820	1690	1740
CO	1220	811	770	635	1810	850	630

(continued)

TABLE C-1 (continued)

Date	8/17/76 7-9	8/17/76 9-11	8/17/76 11-13	8/19/76 7-9 Repeat Analysis	8/19/76 7-9	8/19/76 11-13
Dura Pak						
C_2H_6	14.1	7.9	5.6	19.5	19.2	8.2
C_2H_4	158.1	83.1	79.4	108.3	108.1	30.8
C_3H_8	21.0	11.7	6.6	32.8	32.9	9.0
C_2H_2	21.6	13.5	6.6	19.6	18.5	7.5
$IsoC_4H_{10}$	10.7	7.2	3.0	9.1	9.0	4.8
$N\text{-}C_4H_{10}$	43.8	30.4	14.2	37.7	37.4	21.2
C_3H_6	11.2	8.4	2.3	11.0	11.1	2.3
$IsoC_5H_{12}$	40.0	29.0	13.0	31.0	35.0	19.0
$N\text{-}C_5H_{12}$	19.0	13.0	6.0	25.0	21.0	10.0
Squalane						
$N\text{-}C_6H_{14}$	18				13	
$N\text{-}C_7H_{16}$	8				8	
Toluene	48				57	
$N\text{-}C_8H_{18}$	5				6	
$E\text{-}C_6H_5$	14				25	
M-XYL	39				42	
O-XYL	8				13	
$N\text{-}C_9H_{20}$	5				4	
$N\text{-}P\text{-}C_6H_5$	2				2	
$N\text{-}C_{10}H_{22}$	25				19	

(continued)

TABLE C-1 (continued)

Date	8/24/76 7-9	8/24/76 9-11	8/24/76 11-13	8/24/76 13-15	8/26/76 7-9	8/26/76 9-11	8/26/76 11-13
Dura Pak							
C_2H_6	30.2	10.0	9.0	7.0	18.6	12.3	10.3
C_2H_4	65.5	35.4	103.5	17.3	89.3	117.4	31.1
C_3H_8	70.8	13.4	9.6	9.3	23.9	14.4	12.9
C_2H_2	23.3	10.9	9.9	8.0	48.1	20.9	14.0
$IsoC_4H_{10}$	88.6	8.3	6.6	5.0	27.2	14.7	10.9
$N\text{-}C_4H_{10}$	240.2	35.2	41.3	29.8	144.3	98.9	61.8
C_3H_6	34.8	3.5	2.0	0.8	19.8	7.9	3.7
$IsoC_5H_{12}$	163.0	24.0	25.0	19.0	147.0	80.0	49.0
$N\text{-}C_5H_{12}$	98.0	14.0	14.0	10.0	61.0	33.0	21.0
Squalane							
$N\text{-}C_6H_{14}$					26		
$N\text{-}C_7H_{16}$					8		
Toluene					59		
$N\text{-}C_8H_{18}$					6		
$E\text{-}C_6H_5$					23		
M-XYL					66		
O-XYL					23		
$N\text{-}C_9H_{20}$					5		
$N\text{-}P\text{-}C_6H_5$					4		
$N\text{-}C_{10}H_{22}$					14		
Beckman 6800							
THC	4570	2750	2490	2060	3750	3200	2760
CH_4	2600	1960	1880	1740	2310	1940	1960
CO	2020	780	860	460	3180	1520	1200

(continued)

TABLE C-1 (continued)

Date	8/26/76 13-15	8/10/76 13-15
Dura Pak		
C_2H_6	9.9	4.8
C_2H_4	112.2	11.4
C_3H_8	9.4	7.4
C_2H_2	10.3	7.9
$IsoC_4H_{10}$	7.9	8.5
$N\text{-}C_4H_{10}$	49.5	41.2
C_3H_6	3.4	2.3
$IsoC_5H_{12}$	43.0	29.0
$N\text{-}C_5H_{12}$	14.0	13.0
Beckman 6800		
THC	3290	2600
CH_4	1840	1800
CO	1010	990

TABLE C-2. RAMS STATION 102

SUMMER INTENSIVE

	Mean	Standard Deviation
THC	2660 ppbC	306 ppbC
CH_4	1972 ppbC	97 ppbC
CO	935 ppbC	214 ppbC

Date	6/23/76 7-9	6/23/76 9-11	6/23/76 11-13	6/23/76 13-15
Beckman 6800				
THC	3010	2820	2440	2370
CH_4	1970	2110	1900	1910
CO	1100	1140	750	750

TABLE C-3. RAMS STATION 103

SUMMER INTENSIVE

	Mean	Standard Deviation
THC	2327 ppbC	424 ppbC
CH_4	1860 ppbC	273 ppbC
CO	763 ppbC	412 ppbC
C_2H_2	4 ppbC	2 ppbC

Date	6/28/76 7-9	6/28/76 9-11	6/28/76 11-13	6/28/76 13-15	6/30/76 7-9	6/30/76 9-11	6/30/76 11-13
Beckman 6800							
THC	3670	2530	2280	2350	2210	2070	2140
CH_4	3200	1920	1900	1850	1900	1880	1820
CO	1400	870	880	750	740	630	660

(continued)

TABLE C-3 (continued)

Date	6/30/76 13-15	7/13/76 11-13	7/13/76 13-15	7/15/76 7-9	7/15/76 9-11	7/20/76 7-9	7/20/76 9-11
Dura Pak							
C_2H_6		5.8	7.5	8.6	5.7	6.9	7.2
C_2H_4		26.2	14.3	23.8	1128.0	26.8	224.2
C_3H_8		10.9	13.4	7.6	5.9	9.0	8.6
C_2H_2		3.3	4.7	5.0	2.1	5.6	3.7
$IsoC_4H_{10}$		3.4	7.3	4.2	2.0	6.5	3.7
$N\text{-}C_4H_{10}$		12.7	31.8	18.2	8.5	42.8	17.5
C_3H_6		BDL*	Trace	BDL*	BDL*	3.7	BDL*
$IsoC_5H_{12}$		9.0	22.0	14.0	6.5	27.0	12.0
$N\text{-}C_5H_{12}$		1.0	9.0	4.5	1.4	8.0	4.8
Squalane							
$N\text{-}C_6H_{14}$						NM**	
$N\text{-}C_7H_{16}$						2	
Toluene						49	
$N\text{-}C_8H_{18}$						2	
$E\text{-}C_6H_5$						31	
M-XYL						138	
O-XYL						27	
$N\text{-}C_9H_{20}$						2	
$N\text{-}P\text{-}C_6H_5$						BDL*	
$N\text{-}C_{10}H_{22}$						36	
Beckman 6800							
THC	2090	2090	2240	2470	3570	2730	2650
CH_4	1840	1910	1870	2030	1990	1880	1780
CO	370	610	800	1220	840	1170	990

* Below detection limits
** Not measurable (because of interference etc.)

(continued)

TABLE C-3 (continued)

Date	7/20/76 11-13	7/20/76 13-15	7/22/76 7-9	7/22/76 9-11	7/22/76 13-15	7/27/76 7-9	7/27/76 9-11
Dura Pak							
C_2H_6	4.8	3.9	10.7	8.1	5.2	11.8	6.9
C_2H_4	38.9	13.6	69.0	32.8	26.5	20.1	19.9
C_3H_8	4.9	3.9	34.8	16.5	18.0	37.9	11.5
C_2H_2	1.5	1.5	9.1	5.5	2.2	6.6	4.3
$IsoC_4H_{10}$	3.7	3.1	23.1	4.5	2.6	15.6	6.7
$N\text{-}C_4H_{10}$	15.8	13.6	62.9	18.4	13.1	37.8	19.1
C_3H_6	BDL*	BDL*	5.9	2.8	BDL*	49.8	40.4
$IsoC_5H_{12}$	10.0	8.0	38.0	15.0	5.0	26.0	15.0
$N\text{-}C_5H_{12}$	4.8	3.0	15.0	6.0	4.0	13.0	6.0
Squalane							
$N\text{-}C_6H_{14}$			25			11	
$N\text{-}C_7H_{16}$			211			3	
Toluene			586			16	
$N\text{-}C_8H_{18}$			1008			2	
$E\text{-}C_6H_5$			1262			14	
M-XYL			1695			39	
O-XYL			3423			10	
$N\text{-}C_9H_{20}$			1426			2	
$N\text{-}P\text{-}C_6H_5$			6			2	
$N\text{-}C_{10}H_{22}$			24			BDL*	
Beckman 6800							
THC	2340	2160	1390	2310	1980	2500	2180
CH_4	1760	1720	2000	1800	1760	1520	1470
CH	380	430	2510	1050	440	550	410

* Below detection limits

(continued)

TABLE C-3 (continued)

Date	Special Bags 7/27/76 11-13	7/27/76 13-15	7/29/76 0800-0815	7/29/76 1515-1530	7/29/76 7-9	7/29/76 9-11	7/29/76 11-13
Dura Pak							
C_2H_6	7.1	6.5	55.4	55.3	9.7	10.1	12.0
C_2H_4	15.2	13.7	68.6	61.4	24.7	27.6	48.8
C_3H_8	13.0	8.9	19.2	18.9	19.3	18.0	19.8
C_2H_2	4.0	3.0	† 7.9	† 7.0	7.6	7.0	8.5
$IsoC_4H_{10}$	2.8	2.3	11.2	9.5	5.6	5.2	8.0
$N\text{-}C_4H_{10}$	9.8	7.6	117.7	98.9	19.2	18.1	30.9
C_3H_6	35.6	20.4	8.9	1.8	12.2	12.7	10.0
$IsoC_5H_{12}$	7.8	4.0	88.0	64.0	19.0	18.0	26.0
$N\text{-}C_5H_{12}$	3.0	1.0	15.0	14.0	7.3	7.7	11.0
Squalane							
$N\text{-}C_6H_{14}$					5		
$N\text{-}C_7H_{16}$					1		
Toluene					27		
$N\text{-}C_8H_{18}$					2		
$E\text{-}C_6H_5$					10		
M-XYL					29		
O-XYL					8		
$N\text{-}C_9H_{20}$					2		
$N\text{-}P\text{-}C_6H_5$					2		
$N\text{-}C_{10}H_{22}$					2		
Beckman 6800							
THC	2690	2090	† 2650	2790	2190	2220	2420
CH_4	1740	1680	1970	1760	1880	1920	1710
CO	410	390	2070	2230	810	840	811

†Values are not included in calculations

(continued)

TABLE C-3 (continued)

Date	8/3/76 7-9	8/3/76 9-11	8/3/76 11-13	8/3/76 13-15	8/5/76 7-9	8/5/76 9-11	8/5/76 11-13
Dura Pak							
C_2H_6	11.2	4.7	4.0	5.9	6.8	8.4	6.0
C_2H_4	37.3	18.3	8.4	19.5	8.4	29.4	17.9
C_3H_8	24.3	7.2	4.9	7.5	31.0	17.6	12.4
C_2H_2	4.1	2.9	2.2	2.7	3.3	5.8	3.4
$IsoC_4H_{10}$	3.5	2.5	2.3	4.8	15.8	8.0	6.6
$N\text{-}C_4H_{10}$	11.5	9.5	7.2	4.8	47.6	59.2	22.4
C_3H_6	5.1	11.8	2.2	4.0	2.0	2.0	1.0
$IsoC_5H_{12}$	10.0	8.0	3.0	6.0	40.0	32.0	17.0
$N\text{-}C_5H_{12}$	4.0	3.0	NM**	3.0	9.0	10.0	8.0
Squalane							
$N\text{-}C_6H_{14}$	3				38		
$N\text{-}C_7H_{16}$	1				1		
Toluene	8				16		
$N\text{-}C_8H_{18}$	BDL*				3		
$E\text{-}C_6H_5$	4				7		
M-XYL	13				29		
O-XYL	2				5		
$N\text{-}C_9H_{20}$	Trace				1		
$N\text{-}P\text{-}C_6H_5$	Trace				1		
$N\text{-}C_{10}H_{22}$	1				3		
Beckman 6800							
THC	2270	1940	1950	2100	2360	2360	2360
CH_4	1920	1750	1830	1710	1800	1770	1720
CO	570	530	450	560	670	820	660

* Below detection limits
** Not measurable (because of interference etc.)

(continued)

TABLE C-3 (continued)

Date	8/5/76 13-15
Dura Pak	
C_2H_6	5.3
C_2H_4	19.2
C_3H_8	8.5
C_2H_2	2.5
$IsoC_4H_{10}$	4.9
$N\text{-}C_4H_{10}$	26.2
C_3H_6	1.0
$IsoC_5H_{12}$	18.0
$N\text{-}C_5H_{12}$	6.0

TABLE C-4. RAMS STATION 108

SUMMER INTENSIVE

	Mean	Standard Deviation
THC	2223 ppbC	270 ppbC
CH_4	1872 ppbC	98 ppbC
CO	603 ppbC	388 ppbC

Date	6/23/76 7-9	6/23/76 11-13	6/23/76 13-15	6/28/76 9-11	6/28/76 11-13
Beckman 6800					
THC	2870	2260	2210	2260	2210
CH_4	2130	1840	1840	1840	1840
CO	1480	680	520	680	560

Date	6/30/76 7-9	6/30/76 9-11	6/30/76 11-13	6/30/76 13-15
Beckman 6800				
THC	2190	2100	1980	1930
CH_4	1880	1820	1840	1820
CO	410	740	180	180

TABLE C-5. RAMS STATION 113

SUMMER INTENSIVE

	Mean	Standard Deviation
THC	1874 ppbC	78 ppbC
CH_4	1912 ppbC	82 ppbC
CO	957 ppbC	167 ppbC

Date	7/6/76 7-9	7/6/76 9-11	7/6/76 13-15
Beckman 6800			
THC	1963	1816	1843
CH_4	1995	1912	1830
CO	1150	861	861

TABLE C-6. RAMS STATION 114

SUMMER INTENSIVE

	Mean	Standard Deviation
THC	2613 ppbC	912 ppbC
CH_4	1851 ppbC	310 ppbC
CO	599 ppbC	302 ppbC
C_2H_2	7.1 ppbC	8.9 ppbC

Date	6/23/76 9-11	6/23/76 11-13	6/23/76 13-15	7/15/76 9-11	7/15/76 11-13	7/15/76 13-15	7/20/76 9-11
Dura Pak							
C_2H_6				4.8	4.6	2.4	5.7
C_2H_4				16.4	21.8	10.9	20.5
C_3H_8				4.8	4.8	2.8	6.3
C_2H_2				1.7	1.4	0.7	3.0†
$IsoC_4H_{10}$				1.0	1.0	1.0	3.6
$N\text{-}C_4H_{10}$				6.1	6.6	4.4	15.4
C_3H_6				BDL*	BDL*	0.5	BDL*
$IsoC_5H_{12}$				5.0	4.0	2.0	10.5
$N\text{-}C_5H_{12}$				1.0	1.0	1.0	2.3
Beckman 6800							
THC	2200	2750	2160	2450	2330	2350	2490
CH_4	1820	1840	1840	1960	1920	1650	1760
CO	520	560	540	550	400	330	460

* Below detection limits

(continued)

TABLE C-6 (continued)

Date	7/20/76 11-13	7/20/76 13-15	7/22/76 9-11	7/22/76 11-13	7/22/76 13-15	7/27/76 9-11	7/27/76 11-13
Dura Pak							
C_2H_6	5.0	3.9	8.2	7.5	5.5	7.5	6.6
C_2H_4	32.6	9.7	15.5	41.9	10.8	19.2	27.8
C_3H_8	4.9	3.7	8.9	7.6	4.9	14.7	10.1
C_2H_2	2.0	2.0	4.7	2.9	1.0	3.7	2.6
$IsoC_4H_{10}$	3.0	1.8	4.1	2.6	2.1	8.6	3.3
$N\text{-}C_4H_{10}$	12.8	9.8	14.2	12.4	11.2	19.0	9.9
C_3H_6	BDL*	BDL*	0.7	BDL*	BDL*	31.0	51.7
$IsoC_5H_{12}$	10.0	6.8	14.0	10.0	9.0	11.0	4.0
$N\text{-}C_5H_{12}$	3.0	3.0	5.0	4.0	3.0	6.0	6.0
Beckman 6800							
THC	2650	2240	2080	2040	1950	2090	2470
CH_4	1740	1610	1820	1800	1760	1390	1660
CO	410	480	660	410	480	340	340

Date	7/27/76 13-15	7/29/77 11-13	8/3/76 11-13	8/3/76 13-15	8/5/76 9-11	8/5/76 11-13	8/5/76 13-15
Dura Pak							
C_2H_6	6.8	14.9	7.7	5.5	13.3	5.7	4.6
C_2H_4	39.9	29.6	113.3	17.0	52.9	102.5	10.5
C_3H_8	8.8	25.8	18.6	11.2	12.1	5.5	3.5
C_2H_2	2.0	5.6	2.8	2.4	11.5	5.3	2.7
$IsoC_4H_{10}$	2.5	14.3	16.2	13.1	7.4	3.8	1.8
$N\text{-}C_4H_{10}$	8.4	35.7	48.1	35.2	34.9	17.3	8.5
C_3H_6	35.0	13.0	24.5	10.3	4.5	6.5	BDL*
$IsoC_5H_{12}$	2.0	25.0	27.0	35.0	31.0	13.0	6.0
$N\text{-}C_5H_{12}$	3.0	11.0	14.0	11.0	15.0	7.0	3.0
Beckman 6800							
THC		2300	2450	3870	2110	2740	2120
CH_4		1680	1790	2230	1710	1720	1670
CO		510	340	650	840	840	730

* Below detection limits

(continued)

TABLE C-6 (continued)

Date	8/10/76 9-11	8/10/76 11-13	8/10/76 13-15	8/12/76 7-9	8/12/76 9-11	8/12/76 13-15	8/17/76 7-9
Dura Pak							
C_2H_6	5.5	51.9	4.2	37.6	6.7	5.4	6.2
C_2H_4	19.6	26.6	10.2	20.5	20.8	11.5	26.1
C_3H_8	6.1	26.9	7.5	19.8	7.4	5.7	15.1
C_2H_2	5.7	49.4	3.8	18.1	6.7	21.7	5.3
$IsoC_4H_{10}$	4.0	21.6	4.6	9.1	3.0	1.0	7.1
$N\text{-}C_4H_{10}$	18.7	56.3	19.8	29.0	12.5	4.7	27.4
C_3H_6	0.9	13.0	BDL*	6.0	1.5	BDL*	2.2
$IsoC_5H_{12}$	15.0	59.0	14.0	26.0	11.0	3.0	13.0
$N\text{-}C_5H_{12}$	6.0	53.0	6.0	39.0	5.0	2.0	9.0
Squalane							
$N\text{-}C_6H_{14}$				9			9
$N\text{-}C_7H_{16}$				14			3
Toluene				45			14
$N\text{-}C_8H_{18}$				3			1
$E\text{-}C_6H_5$				30			5
M-XYL				89			19
O-XYL				24			5
$N\text{-}C_9H_{20}$				3			1
$N\text{-}P\text{-}C_6H_5$				1			NM**
$N\text{-}C_{10}H_{22}$				8.			1
Beckman 6800							
THC				2370	2110	2090	
CH_4				1880	1690	1670	
CO				590	580	290	

* Below detection limits

** Not measurable (because of interference etc.)

(continued)

TABLE C-6 (continued)

Date	8/17/76 9-11	8/17/76 11-13	8/18/76 13-15	8/19/76 7-9	8/19/76 9-11	8/19/76 11-13	8/19/76 13-15
Dura Pak							
C_2H_6	6.5	5.2	4.8	15.2	13.1	6.1	5.8
C_2H_4	30.8	14.9	13.2	19.6	42.7	14.3	15.0
C_3H_8	13.0	8.4	6.6	55.5	53.5	6.1	8.8
C_2H_2	4.2	5.0	6.3	4.9	5.8	3.7	2.2
$IsoC_4H_{10}$	4.7	4.3	2.5	44.3	11.1	2.3	2.1
$N\text{-}C_4H_{10}$	15.8	20.1	11.3	131.1	46.5	8.1	8.0
C_3H_6	2.1	1.3	1.0	BDL*	BDL*	BDL*	BDL*
$IsoC_5H_{12}$	11.0	15.0	10.0	65.0	26.0	5.0	5.0
$N\text{-}C_5H_{12}$	5.0	6.0	3.0	42.0	11.0	3.0	3.0
Squalane							
$N\text{-}C_6H_{14}$				24			
$N\text{-}_7H_{16}$				17			
Toluene				21			
$N\text{-}C_8H_{18}$				9			
$E\text{-}C_6H_5$				12			
M-XYL				30			
O-XYL				10			
$N\text{-}C_9H_{20}$				2			
$N\text{-}P\text{-}C_6H_5$				1			
$N\text{-}C_{10}H_{22}$				5			

* Below detection limits

(continued)

TABLE C-6 (continued)

Date	8/26/76 7-9	8/26/76 9-11	8/31/76 7-9	8/31/76 9-11	9/2/76 7-9	9/2/76 9-11	9/2/76 13-15
Dura Pak							
C_2H_6	15.8	14.2	57.3	13.7	15.4	7.6	4.6
C_2H_4	35.4	37.0	24.9	55.0	18.2	25.3	31.6
C_3H_8	19.5	15.9	40.1	35.6	51.1	24.4	5.1
C_2H_2	10.1	15.3	21.5	16.3	3.2	2.0	2.3
$IsoC_4H_{10}$	8.3	7.8	38.0	23.8	73.9	20.1	2.0
$N\text{-}C_4H_{10}$	30.0	37.0	173.3	61.1	210.2	77.6	7.5
C_3H_6	3.9	4.7	10.7	6.1	19.7	73.9	0.7
$IsoC_5H_{12}$	25.0	32.0	193.0	52.0	95.0	45.0	8.0
$N\text{-}C_5H_{12}$	11.0	14.0	98.0	25.0	69.0	19.0	2.0
Squalane							
$N\text{-}C_6H_{14}$	11		15		36		
$N\text{-}C_7H_{16}$	2		5		15		
Toluene	23		56		21		
$N\text{-}C_8H_{18}$	2		4		2		
$E\text{-}C_6H_5$	11		52		17		
M-XYL	32		131		55		
O-XYL	9		37		14		
$N\text{-}C_9H_{20}$	1		2		2		
$N\text{-}P\text{-}C_6H_5$	1		11		2		
$N\text{-}C_{10}H_{22}$	8		7		1		
Beckman 6800							
THC	2850	2910	6140	3000	2800	2020	1780
CH_4	2290	2200	3100	2220	1690	1720	1690
CO	830	1200	1330	1540	450	350	410

TABLE C-7. RAMS STATION 115

SUMMER INTENSIVE

	Mean	Standard Deviation
THC	2427 ppbC	908 ppbC
CH_4	1788 ppbC	147 ppbC
CO	498 ppbC	213 ppbC
C_2H_2	3 ppbC	2 ppbC

Date	6/28/76 9-11	6/28/76 11-13	6/28/76 13-15	6/30/76 9-11	6/30/76 11-13	6/30/76 13-15	
Beckman 6800							
THC	2660	2490	2550	2310	2330	2120	
CH_4	1880	1880	1900	1840	1800	1840	
CO	550	650	430	630	260	260	
Date	7/13/76 13-15	7/15/76 9-11	7/15/76 11-13	7/15/76 13-15	7/20/76 9-11	7/20/76 11-13	7/20/76 13-15
Dura Pak							
C_2H_6	7.6	4.7	3.4	2.5	5.7	4.8	4.2
C_2H_4	20.6	33.9	28.5	36.2	34.0	52.8	31.2
C_3H_8	14.8	4.6	3.1	2.1	6.6	5.0	4.3
C_2H_2	3.0	1.7	2.2	0.9	2.5	2.3	2.4
$IsoC_4H_{10}$	4.9	1.5	1.4	0.9	3.1	2.0	2.3
$N\text{-}C_4H_{10}$	10.9	5.6	5.3	4.2	12.9	8.4	9.6
C_3H_6	2.0	BDL*	BDL*	BDL*	BDL*	BDL*	BDL*
$IsoC_5H_{12}$	8.0	3.0	2.0	3.0	5.0	7.0	8.0
$N\text{-}C_5H_{12}$	2.9	1.0	BDL*	BDL*	3.0	2.0	2.0
Beckman 6800							
THC	2160	2520	2260	2140	2220	2170	2090
CH_4	1870	1930	1870	1830	1760	1720	1720
CO	860	490	330	610	690	410	410

* Below detection limits

(continued)

TABLE C-7 (continued)

Date	7/22/76 9-11	7/22/76 13-15	7/27/76 9-11	7/27/76 11-13	7/27/76 13-15	7/29/76 9-11	7/29/76 11-13
Dura Pak							
C_2H_6	9.9	6.0	6.6	6.8	5.7	13.9	11.0
C_2H_4	38.8	24.2	33.2	39.9	17.6	19.8	25.4
C_3H_8	14.6	5.2	9.0	8.8	5.1	22.8	16.2
C_2H_2	6.3	1.3	3.1	2.0	1.5	6.9	3.9
$IsoC_4H_{10}$	7.0	2.1	4.8	2.5	1.2	9.4	7.8
$N\text{-}C_4H_{10}$	24.1	10.6	12.1	8.4	4.8	27.9	22.5
C_3H_6	BDL*	BDL*	44.9	35.0	19.3	14.2	11.0
$IsoC_5H_{12}$	19.0	9.0	6.0	2.0	2.0	26.0	15.0
$N\text{-}C_5H_{12}$	9.0	2.0	2.0	4.0	BDL*	10.0	7.0
Beckman 6800							
THC	2210	2010	3830	2460	2080	2030	2860
CH_4	1920	1770	1350	1610	1580	2060	1650
CO	160	380	280	330	330	950	450

Date	7/29/76 13-15	8/3/76 9-11	8/3/76 11-13	8/3/76 13-15	8/5/76 9-11
Dura Pak					
C_2H_6	11.3	3.2	8.0	2.9	7.4
C_2H_4	12.9	21.6	36.0	17.0	27.8
C_3H_8	16.9	3.1	5.2	1.9	10.1
C_2H_2	4.5	2.6	10.4	1.9	6.8
$IsoC_4H_{10}$	8.0	2.1	6.0	2.0	4.0
$N\text{-}C_4H_{10}$	23.7	10.9	37.1	7.3	22.6
C_3H_6	8.1	14.4	2890.9	6.7	19.2
$IsoC_5H_{12}$	14.0	10.0	28.0	3.0	18.0
$N\text{-}C_5H_{12}$	7.0	3.0	6.0	2.0	9.0
Beckman 6800					
THC	1060	1980	6200	2000	2230
CH_4	1670	1690	1980	1800	1790
CO	440	700	350	560	940

* Below detection limits

TABLE C-8. RAMS STATION 118

SUMMER INTENSIVE

	Mean	Standard Deviation
THC	2791 ppbC	1311 ppbC
CH_4	1770 ppbC	133 ppbC
CO	479 ppbC	301 ppbC
C_2H_2	3.4 ppbC	2.3 ppbC

Date	7/13/76 13-15	7/15/76 7-9	7/15/76 13-15	7/20/76 7-9	7/22/76 7-9	7/22/76 13-15	7/27/76 7-9
Dura Pak							
C_2H_6	6.2	5.0	2.1	4.8	6.6	4.6	6.3
C_2H_4	41.4	15.0	7.9	24.8	9.3	13.5	18.2
C_3H_8	27.6	6.8	2.0	4.6	8.3	3.9	7.7
C_2H_2	3.5	2.7	0.6	1.5	1.1	0.2	5.6
$IsoC_4H_{10}$	2.4	1.2	0.5	1.1	2.4	1.2	3.3
$N\text{-}C_4H_{10}$	6.6	7.9	2.4	6.4	9.7	3.9	14.6
C_3H_6	BDL	BDL	BDL	BDL	BDL	0.7	12.7
$IsoC_5H_{12}$	3.0	5.0	1.0	2.0	4.0	2.0	8.0
$N\text{-}C_5H_{12}$	1.0	2.0			14.0	1.0	2.0
Squalane							
$N\text{-}C_6H_{14}$				NM			2
$N\text{-}C_7H_{16}$				8			1
Toluene				26			4
$N\text{-}C_8H_{18}$				23			1
$E\text{-}C_6H_5$				19			5
M-XYL				84			18
O-XYL				21			6
$N\text{-}C_9H_{20}$				37			Trace
$N\text{-}P\text{-}C_6H_5$				1			Trace
$N\text{-}C_{10}H_{22}$				126			1
Beckman 6800							
THC	3850	2330	2280	2340		2670	2080
CH_4	1870	1900	1870	1820		1740	1480
CO	1380	580	210	356		191	380

(continued)

TABLE C-8 (continued)

Date	7/27/76 13-15	7/29/76 7-9	7/29/76 13-15	8/03/76 7-9	8/03/76 13-15	8/05/76 7-9	8/05/76 13-15
Dura Pak							
C_2H_6	7.8	6.4	8.4	6.2	3.8	5.3	4.2
C_2H_4	4.3	25.2	22.7	32.5	11.2	27.2	12.6
C_3H_8	5.5	7.6	10.2	22.7	7.0	4.7	3.0
C_2H_2	4.1	4.7	5.0	5.2	2.8	1.9	1.3
$IsoC_4H_{10}$	1.8	2.8	3.1	6.5	3.5	1.8	0.8
$N\text{-}C_4H_{10}$	7.8	15.3	15.8	20.0	13.5	5.6	3.2
C_3H_6	10.0	24.4	19.4	92.0	BDL*	BDL*	BDL*
$IsoC_5H_{12}$	6.0	11.0	11.0	12.0	9.0	3.0	2.0
$N\text{-}C_5H_{12}$	1.0	2.0	3.0	9.0	4.0	5.2	1.2
Squalane							
$N\text{-}C_6H_{14}$		2		5		1	
$N\text{-}C_7H_{16}$		1		2		Trace	
Toluene		13		6		3	
$N\text{-}C_8H_{18}$		2		2		1	
$E\text{-}C_6H_5$		10		3		3	
M-XYL		43		11		17	
O-XYL		9		4		2	
$N\text{-}C_9H_{20}$		1		1		Trace	
$N\text{-}P\text{-}C_6H_5$		1		Trace		BDL*	
$N\text{-}C_{10}H_{22}$		21		2		1	
Beckman 6800							
THC	6070	2030	2610	2280	2130	2060	2100
CH_4	1990	1780	1610	1810	1750	1720	1670
CO	460	490	430	530	590	410	230

* Below detection limits

TABLE C-9. RAMS STATION 121

SUMMER INTENSIVE

	Mean	Standard Deviation
THC	1960 ppbC	311 ppbC
CH_4	1872 ppbC	43 ppbC
CO	364 ppbC	183 ppbC

Date	7/6/76 9-11	7/6/76 11-13	7/6/76 13-15	7/8/76 9-11	7/8/76 13-15
Beckman 6800					
THC	1790	1880	2500	1910	1720
CH_4	1870	1930	1830	1900	1830
CO	660	370	717	350	270

TABLE C-10. RAMS STATION 122

SUMMER INTENSIVE

	Mean	Standard Deviation
THC	2939 ppbC	1771 ppbC
CH_4	1864 ppbC	212 ppbC
CO	607 ppbC	240 ppbC
C_2H_2	5 ppbC	3 ppbC

Date	8/10/76 13-15	8/12/76 7-9	8/12/76 13-15	8/17/76 7-9	8/17/76 13-15	8/19/76 13-15
Dura Pak						
C_2H_6	4.5	12.3	7.4	4.2	2.9	4.9
C_2H_4	6.4	15.4	16.1	6.6	5.3	6.5
C_3H_8	6.0	26.1	6.8	8.5	3.4	4.3
C_2H_2	5.0	8.4	4.4	4.1	2.0	2.4
$IsoC_4H_{10}$	3.3	20.4	2.3	2.3	0.9	1.3
$N\text{-}C_4H_{10}$	15.8	47.2	7.8	9.1	3.4	4.2
C_3H_6	BDL*	4.9	1.0	1.1	BDL*	BDL*
$IsoC_5H_{12}$	12.0	36.0	7.0	6.0	1.9	2.0
$N\text{-}C_5H_{12}$	4.0	18.0	3.0	2.0	0.8	2.0
Squalane						
$N\text{-}C_6H_{14}$				2		
$N\text{-}C_7H_{16}$				3		
Toluene				12		
$N\text{-}C_8H_{18}$				Trace		
$E\text{-}C_6H_5$				8		
M-XYL				28		
O-XYL				5		
$N\text{-}C_9H_{20}$				Trace		
$N\text{-}P\text{-}C_6H_5$				1		
$N\text{-}C_{10}H_{22}$				2		
Beckman 6800						
THC	2070	2580	1950			
CH_4	1810	1840	1670			
CO	450	650	300			

* Below detection limits

(continued)

TABLE C-10 (continued)

Date	8/24/76 7-9	8/24/76 13-15	8/26/76 7-9	8/26/76 13-15	8/31/76 7-9	8/31/76 13-15	9/2/76 7-9
Dura Pak							
C_2H_6	7.5	5.8	9.4	7.7	18.1	8.4	0.7
C_2H_4	18.9	8.1	43.3	25.6	16.8	5.7	3.1
C_3H_8	10.1	4.6	10.0	7.4	29.1	28.2	4.4
C_2H_2	3.9	3.0	10.0	3.9	10.6	5.3	1.3
$IsoC_4H_{10}$	2.0	1.7	7.1	2.1	12.4	23.4	1.0
$N\text{-}C_4H_{10}$	7.8	4.1	31.2	6.7	43.1	76.3	4.2
C_3H_6	0.7	BDL*	1.3	0.4	5.3	1.1	0.1
$IsoC_5H_{12}$	5.0	3.0	22.0	5.0	37.0	46.0	2.0
$N\text{-}C_5H_{12}$	3.0	2.0	13.0	2.0	17.0	27.0	7.0
Squalane							
$N\text{-}C_6H_{14}$			6		10		5
$N\text{-}C_7H_{16}$			2		2		5
Toluene			18		24		4
$N\text{-}C_8H_{18}$			1		2		1
$E\text{-}C_6H_5$			16		12		5
M-XYL			48		31		16
O-XYL			14		10		4
$N\text{-}C_9H_{20}$			1		1		1
$N\text{-}P\text{-}C_6H_5$			2		1		1
$N\text{-}C_{10}H_{22}$			8		5		2
Beckman 6800							
THC	2270	2080	2520	2210	2750	2160	1600
CH_4	1890	1690	1900	1800	2390	1800	1650
CO	460	400	760	490	970	620	310

* Below detection limits

(continued)

TABLE C-10 (continued)

Date	9/2/76 13-15
Dura Pak	
C_2H_6	4.7
C_2H_4	5.1
C_3H_8	5.2
C_2H_2	1.9
$IsoC_4H_{10}$	1.9
$N\text{-}C_4H_{10}$	5.8
C_3H_6	
$IsoC_5H_{12}$	3.0
$N\text{-}C_5H_{12}$	2.0

TABLE C-11. RAMS STATION 124

SUMMER INTENSIVE

	Mean	Standard Deviation
THC	2264 ppbC	382 ppbC
CH_4	1931 ppbC	402 ppbC
CO	579 ppbC	214 ppbC
C_2H_2	3 ppbC	2 ppbC

Date	8/12/76 7-9	8/12/76 13-15	8/17/76 11-13	8/24/76 7-9	8/26/76 7-9	8/26/76 13-15	8/31/76 7-9
Dura Pak							
C_2H_6	4.8	7.6	8.4	10.4	6.0	7.2	1.8
C_2H_4	255.8	40.0	112.9	54.1	151.7	113.5	38.5
C_3H_8	5.5	6.9	15.6	14.8	5.9	5.9	5.7
C_2H_2	2.5	2.6	2.6	7.1	2.6	1.7	3.5
$IsoC_4H_{10}$		1.8	3.1	5.2	1.1	1.7	1.5
$N\text{-}C_4H_{10}$	4.4	4.3	11.7	30.8	4.5	6.2	8.4
C_3H_6				1.9	0.9	0.5	1.6
$IsoC_5H_{12}$	3.0	3.0	4.0	14.0	3.0	5.0	5.0
$N\text{-}C_5H_{12}$	2.0	2.0	3.0	6.0	3.0	4.0	3.0
Squalane							
$N\text{-}C_6H_{14}$							
$N\text{-}C_7H_{16}$							
Toluene							
$N\text{-}C_8H_{18}$							
$E\text{-}C_6H_5$							
M-XYL							
O-XYL							
$N\text{-}C_9H_{20}$							
$N\text{-}P\text{-}C_6H_5$							
$N\text{-}C_{10}H_{22}$							
Beckman 6800							
THC	2380	1950		2270	2630	2210	
CH^4	1720	1670		1890	1900	1930	
CO	290	300		460	460	300	

(continued)

TABLE C-11 (continued)

Date	8/31/76 13-15	9/2/76 7-9	9/2/76 13-15
Dura Pak			
C_2H_6	6.3	6.9	5.4
C_2H_4	278.6	111.0	180.8
C_3H_8	4.3	13.1	7.7
C_2H_2	2.9	2.4	1.6
$IsoC_4H_{10}$	2.0	3.2	2.4
$N\text{-}C_4H_{10}$	6.9	10.5	7.1
C_3H_6	0.7	0.9	0.5
$IsoC_5H_{12}$	5.0	5.0	5.0
$N\text{-}C_5H_{12}$	3.0	3.0	3.0
Squalane			
$N\text{-}C_6H_{14}$			
$N\text{-}C_7H_{16}$			
Toluene			
$N\text{-}C_8H_{18}$			
$E\text{-}C_6H_5$			
M-XYL			
O-XYL			
$N\text{-}C_9H_{20}$			
$N\text{-}P\text{-}C_6H_5$			
$N\text{-}C_{10}H_{22}$			
Beckman 6800			
THC	2900	1910	1850
CH_4	2140	1750	1690
CO	620	280	220

TABLE C-12. RAMS STATION 101

	FALL INTENSIVE Mean	Standard Deviation
THC	2906 ppbC	789 ppbC
CH_4	1734 ppbC	240 ppbC
CO	1815 ppbC	1322 ppbC
C_2H_2	33 ppbC	26 ppbC

Date	11/8/76 13-15	11/10/76 7-9	11/10/76 9-11	11/10/76 11-13	11/10/76 13-15	11/12/76 9-11	11/12/76 13:30-15
Dura Pak							
C_2H_6	18.0	11.9	10.4	7.9	6.4	9.2	7.6
C_2H_4	46.4	24.3	20.4	10.7	7.7	21.1	16.5
C_3H_8	11.4	6.8	8.8	5.2	4.9	9.0	6.6
C_2H_2	40.3	25.8	13.6	5.3	5.7	18.2	10.2
$IsoC_4H_{10}$	11.8	6.7	5.0	3.1	3.3	4.9	3.1
$N\text{-}C_4H_{10}$	47.5	29.6	22.8	15.4	16.0	20.9	12.8
C_3H_6	12.4	7.0	6.0	3.4	2.1	4.1	1.5
$IsoC_5H_{12}$	44.0	28.0	18.0	9.0	10.0	14.0	9.0
$N\text{-}C_5H_{12}$	22.0	13.0	9.0	6.0	5.0	6.0	5.0
Squalane							
$N\text{-}C_6H_{14}$		NM				7	
$N\text{-}C_7H_{16}$		3				4	
Toluene		38				42	
$N\text{-}C_8H_{18}$		14				3	
$E\text{-}C_6H_5$		11				15	
M-XYL		27				37	
O-XYL		9				10	
$N\text{-}C_9H_{20}$		43				2	
$N\text{-}P\text{-}C_6H_5$		2				1	
$N\text{-}C_{10}H_{22}$		370				4	
Beckman 6800							
THC		2690				2330	1990
CH_4		2040				1580	1470
CO		2115				740	250

(continued)

TABLE C-12 (continued)

Date	11/16/76 7-9	11/16/76 9-11	11/16/76 11-13	11/16/76 13-15	11/18/76 7-9	11/18/76 9-11	11/18/76 11-13
Dura Pak							
C_2H_6	40.0	33.5	30.0	10.7	75.6	66.4	23.8
C_2H_4	87.9	185.5	120.3	19.7	57.4	40.5	28.7
C_3H_8	37.0	43.5	31.3	14.8	75.5	73.4	27.0
C_2H_2	71.2	62.8	87.2	14.2	60.1	42.0	16.7
$IsoC_4H_{10}$	23.0	33.4	47.6	8.4	32.0	27.8	21.0
$N\text{-}C_4H_{10}$	101.3	160.8	187.2	30.8	134.2	103.2	95.0
C_3H_6	26.0	24.5	57.5	5.8	22.2	15.1	8.8
$IsoC_5H_{12}$	92.0	108.0	161.0	23.0	99.0	71.0	61.0
$N\text{-}C_5H_{12}$	38.0	46.0	76.0	11.0	54.0	37.0	28.0
Squalane							
$N\text{-}C_6H_{14}$	29				31		
$N\text{-}C_7H_{16}$	13				5		
Toluene	87				49		
$N\text{-}C_8H_{18}$	10				15		
$E\text{-}C_6H_5$	31				16		
M-XYL	68				40		
O-XYL	28				17		
$N\text{-}C_9H_{20}$	3				35		
$N\text{-}P\text{-}C_6H_5$	4				3		
$N\text{-}C_{10}H_{22}$	15				10		
Beckman 6800							
THC	3900	4020		2310	3860	3300	2540
CH_4	2120	1980		1490	1970	1830	1470
CO	3660	3810		710	3100	2250	900

(continued)

TABLE C-12 (continued)

Date	11/18/76 13-15
Dura Pak	
C_2H_6	46.2
C_2H_4	20.2
C_3H_8	53.3
C_2H_2	17.2
$IsoC_4H_{10}$	22.5
$N\text{-}C_4H_{10}$	99.4
C_3H_6	9.5
$IsoC_5H_{12}$	58.0
$N\text{-}C_5H_{12}$	28.0
Beckman 6800	
THC	2670
CH_4	1610
CO	900

TABLE C-13. RAMS STATION 103

FALL INTENSIVE

	Mean	Standard Deviation
THC	2676 ppbC	817 ppbC
CH_4	1739 ppbC	367 ppbC
CO	1073 ppbC	844 ppbC
C_2H_2	15 ppbC	14 ppbC

Date	11/8/76 7-9	11/8/76 11-13	11/8/76 13-15	11/10/76 7-9	11/10/76 9-11	11/10/76 11-13	11/10/76 13-15
Dura Pak							
C_2H_6	19.1	5.0	45.2	9.7	6.4	9.0	7.8
C_2H_4	47.2	15.4	9.4	31.0	20.1	15.7	16.0
C_3H_8	13.5	4.8	65.7	7.6	7.8	6.0	6.6
C_2H_2	26.0	3.9	7.5	17.7	8.2	5.0	6.6
$IsoC_4H_{10}$	6.8	2.8	17.7	4.5	3.2	4.9	2.8
$N\text{-}C_4H_{10}$	31.5	9.1	63.8	22.2	12.0	43.0	18.4
C_3H_6	7.7	2.5	2.4	6.1	3.0	4.3	3.9
$IsoC_5H_{12}$	30.0	6.0	30.0	17.0	10.0	19.0	7.0
$N\text{-}C_5H_{12}$	14.0	3.0	10.0	7.0	4.0	7.0	5.0
Squalane							
$N\text{-}C_6H_{14}$	11			16			
$N\text{-}C_7H_{16}$	3			2			
Toluene	90			41			
$N\text{-}C_8H_{18}$	14			2			
$E\text{-}C_6H_5$	21			9			
M-XYL	37			22			
O-XYL	15			9			
$N\text{-}C_9H_{20}$	38			2			
$N\text{-}P\text{-}C_6H_5$	3			1			
$N\text{-}C_{10}H_{22}$	258			5			
Beckman 6800							
THC	3066	1785	1850				
CH_4	2270	1683	1767				
CO	1560	281	336				

(continued)

TABLE C-13 (continued)

Date	11/12/76 9-11	11/12/76 1130 - 1330	11/12/76 1330 - 1530	11/16/76 7-9	11/16/76 9-11	11/16/76 11-13	11/16/76 13-15
Dura Pak							
C_2H_6	7.0	6.7	6.3	42.1	30.4	9.0	11.4
C_2H_4	11.9	9.2	9.2	121.6	54.7	7.8	13.2
C_3H_8	7.7	6.5	6.4	223.8	105.7	18.7	34.1
C_2H_2	7.9	4.5	4.8	51.0	39.0	6.0	8.4
$IsoC_4H_{10}$	2.7	2.9	2.1	65.0	30.7	5.7	8.8
$N\text{-}C_4H_{10}$	11.8	11.5	7.6	174.9	148.2	24.9	43.8
C_3H_6	2.2	1.5	1.2	24.6	14.4	1.5	2.4
$IsoC_5H_{12}$	11.0	9.1	6.4	118.0	75.0	11.0	17.0
$N\text{-}C_5H_{12}$	1.0	1.2	1.0	43.0	31.0	4.0	6.0
Squalane							
$N\text{-}C_6H_{14}$	2			48			
$N\text{-}C_7H_{16}$	1			6			
Toluene	6			40			
$N\text{-}C_8H_{18}$	1			5			
$E\text{-}C_6H_5$	4			21			
M-XYL	10			48			
O-XYL	4			16			
$N\text{-}C_9H_{20}$				3			
$N\text{-}P\text{-}C_6H_5$	1			3			
$N\text{-}C_{10}H_{22}$	1			11			
Beckman 6800							
THC	2010	1990	2960	4470	3360	2090	2280
CH_4	1500	1480	1470	2550	1890	1440	1480
CO	490	250	280	2640	2160	410	530

(continued)

TABLE C-13 (continued)

Date	11/18/76 7-9	11/18/76 9-11
Dura Pak		
C_2H_6	58.6	60.6
C_2H_4	23.2	28.3
C_3H_8	69.1	84.8
C_sH_2	15.9	22.7
$IsoC_4H_{10}$	31.6	28.5
$N\text{-}C_4H_{10}$	197.3	139.8
C_3H_6	6.3	7.8
$IsoC_5H_{12}$	57.0	55.0
$N\text{-}C_5H_{12}$	30.0	28.0
Squalane		
$N\text{-}C_6H_{14}$	6	
$N\text{-}C_7H_{16}$	2	
Toluene	24	
$N\text{-}C_8H_{18}$	2	
$E\text{-}C_6H_5$	4	
M-XYL	16	
O-XYL	4	
$N\text{-}C_9H_{20}$	2	
$N\text{-}P\text{-}C_6H_5$	1	
$N\text{-}C_{10}H_{22}$	5	
Beckman 6800		
THC	2920	2990
CH_4	1740	1740
CO	1350	1690

TABLE C-14. RAMS STATION 114

FALL INTENSIVE

	Mean	Standard Deviation
THC	2451 ppbC	1299 ppbC
CH_4	1541 ppbC	581 ppbC
CO	1187 ppbC	1392 ppbC
C_2H_2	19 ppbC	22 ppbC

Date	11/8/76 7-9	11/8/76 13-15	11/10/76 7-9	11/10/76 7-9 Tank (Upwind)	11/10/76 9-11 Tank (Upwind)	11/10/76 11-13	11/10/76 13-15
Dura Pak							
C_2H_6	11.7	6.7	9.4	6.9	5.1	9.9	4.9
C_2H_4	9.6	10.7	16.6	7.8	3.6	5.6	7.0
C_3H_8	8.0	11.2	7.9	6.4	7.2	8.1	4.7
C_2H_2	9.0	8.0	15.1	9.2	2.3	1.7	1.6
$IsoC_4H_{10}$	5.0	6.1	4.4	3.4	1.1	2.4	4.0
$N\text{-}C_4H_{10}$	12.2	29.6	16.4	12.2	3.8	11.1	16.8
C_3H_6	3.9	2.3	4.1	2.9	1.9	0.9	
$IsoC_5H_{12}$	10.0	17.0	15.0	10.0	2.0	11.0	9.0
$N\text{-}C_5H_{12}$	10.0	8.0	6.0	4.0	2.0	6.0	2.0
Squalane							
$N\text{-}C_6H_{14}$	8		6	3			
$N\text{-}C_7H_{16}$	3		2	1			
Toluene	19		13	9			
$N\text{-}C_8H_{18}$	1		1	1			
$E\text{-}C_6H_5$	7		5	9			
M-XYL	15		16	26			
O-XYL	6		8	10			
$N\text{-}C_9H_{20}$	1		BDL*	1			
$N\text{-}P\text{-}C_6H_5$	1		1	1			
$N\text{-}C_{10}H_{22}$	2		1	2			
Beckman 6800							
THC	2654	2254					
CH_4	2140	1863					
CO	1330	536					

* Below detection limits

(continued)

TABLE C-14 (continued)

Date	11/12/76 7-9	11/12/76 0930-1130	11/12/76 1130-1330	11/12/76 1330-1530	Tank 11/12/76 7-9 (Upwind)	Tank 11/12/76 9-11 (Upwind)	11/16/76 7-9
Dura Pak							
C_2H_6	7.8	6.2	5.7	5.4	8.2	6.5	37.0
C_2H_4	11.0	8.3	19.5	4.9	5.3	3.3	94.2
C_3H_8	9.6	6.8	3.4	5.3	10.3	7.4	39.4
C_2H_2	7.4	3.9	28.2	9.3	8.2	4.8	72.8
$IsoC_4H_{10}$	1.7	1.2	2.8	1.7	1.8	1.4	78.0
$N\text{-}C_4H_{10}$	7.8	6.2	7.0	5.0	5.9	4.3	235.9
C_3H_6	1.6	1.1	1.1	1.1	2.6	1.9	36.1
$IsoC_5H_{12}$	4.0	4.0	5.0	4.0	4.0	3.0	156.0
$N\text{-}C_5H_{12}$	4.0	2.0	3.0	2.0	3.0	2.0	71.0
Squalane							
$N\text{-}C_6H_{14}$	NM**	10			2	5	
$N\text{-}C_7H_{16}$	1				1		
Toluene	4	3			5	3	
$N\text{-}C_8H_{18}$	1	1			1	1	
$E\text{-}C_6H_5$	3	1			7	5	
M-XYL	11	4			23	18	
O-XYL	3	1			9	5	
$N\text{-}C_9H_{20}$	Trace	Trace			BDL*	BDL*	
$N\text{-}P\text{-}C_6H_5$	Trace	Trace			1	BDL*	
$N\text{-}C_{10}H_{22}$	1	1			2	1	
Beckman 6800							
THC	2030	1890	2060	1970			5170
CH_4	1540	1470	1460	1450			1880
CO	350	210	170	220			4010

* Below detection limits
** Not measurable (because of interference etc.)

(continued)

TABLE C-14 (continued)

Date	11/16/76 9-11	11/16/76 13-15	11/18/76 7-9	Tank 11/18/76 7-9 (Upwind)
Dura Pak				
C_2H_6	40.3	6.1	66.2	63.0
C_2H_2	72.9	38.4	80.2	23.9
C_3H_8		5.3	69.6	66.4
C_2H_2	69.1	16.7	37.1	32.1
$IsoC_4H_{10}$	25.3	6.8	19.6	17.3
$N\text{-}C_4H_{10}$	108.9	24.2	67.2	57.1
C_3H_6	23.0	7.1	8.7	10.0
$IsoC_5H_{12}$	84.0	18.0	43.0	34.0
$N\text{-}C_5H_{12}$	39.0	10.0	25.0	19.0
Squalane				
$N\text{-}C_6H_{14}$			24	13
$N\text{-}C_7H_{16}$	9		4	4
Toluene	57		39	37
$N\text{-}C_8H_{18}$	6		3	2
$E\text{-}C_6H_5$	17		12	8
M-XYL	43		27	23
O-XYL	17		12	8
$N\text{-}C_9H_{20}$	4		2	1
$N\text{-}P\text{-}C_6H_5$	4		1	1
$N\text{-}C_{10}H_{22}$	10		NM*	2
Beckman 6800				
THC	4010		2990	
CH_4	2190		1770	
CO	3280		1550	

* Not measurable (because of interference etc.)

TABLE C-15. RAMS STATION 115

FALL INTENSIVE

	Mean	Standard Deviation
THC	2321 ppbC	417 ppbC
CH_4	1637 ppbC	225 ppbC
CO	666 ppbC	388 ppbC
C_2H_2	9 ppbC	7 ppbC

Date	11/8/76 7-9:45	11/8/76 13-15	11/10/76 7-9	11/10/76 9-11	11/10/76 11-13	11/10/76 13-15	11/12/76 9:30 - 11:30
Dura Pak							
C_2H_6	11.7	5.4	8.4	6.4	4.8	5.7	13.0
C_2H_4	40.7	27.6	33.4	32.5	42.6	45.2	28.1
C_3H_8	20.5	5.4	10.3	7.0	5.3	5.8	63.7
C_2H_2	14.9	3.8	7.3	2.1	2.7	2.5	7.4
$IsoC_4H_{10}$	8.6	1.7	5.4	3.2	1.8	2.2	28.5
$N\text{-}C_4H_{10}$	24.9	8.1	15.1	8.9	7.9	12.9	53.1
C_3H_6	5.7	1.2	3.2	0.9	BDL*	BDL*	17.5
$IsoC_5H_{12}$	19.0	6.0	11.0	6.0	2.0	8.0	33.0
$N\text{-}C_5H_{12}$	9.0	3.0	4.0	3.0	2.0	3.0	14.0
Squalane							
$N\text{-}C_6H_{14}$	8		17				14
$N\text{-}C_7H_{14}$	2		1				2
Toluene	12		9				9
$N\text{-}C_8H_{18}$	1		1				2
$E\text{-}C_6H_5$	3		5				4
M-XYL	12		17				9
O-XYL	5		6				3
$N\text{-}C_9H_{20}$	1		1				1
$N\text{-}P\text{-}C_6H_5$	1		1				TRACE
$N\text{-}C_{10}H_{22}$	4		5				2
Beckman 6800							
THC	2285		1967				2360
CH_4	2152		1841				1500
CO	768		350				350

* Below detection limits

(continued)

TABLE C-15 (continued)

Date	11/12/76 1130-1330	11/12/76 1330-1530	11/16/76 7-9	11/16/76 9-11	11/16/76 11-13	11/16/76 13-15	11/18/76 7-9
Dura Pak							
C_2H_6	8.3	8.1	23.9	15.0	9.2	10.6	65.8
C_2H_4	24.4	60.0	54.2	30.9	30.1	32.1	37.9
C_3H_8	16.4	19.9	48.5	26.9	20.6	19.6	91.0
C_2H_2	6.2	6.7	24.5	13.8	5.8	8.6	17.2
$IsoC_4H_{10}$	14.5	19.0	11.6	8.0	6.0	5.5	24.0
$N\text{-}C_4H_{10}$	20.9	30.9	41.4	32.5	21.0	19.4	66.9
C_3H_6	4.1	5.8	10.6	5.0	1.2	2.1	12.2
$IsoC_5H_{12}$	13.0	21.0	32.0	16.0	12.0	13.0	33.0
$N\text{-}C_5H_{12}$	5.0	8.0	16.0	9.0	4.0	5.0	19.0
Squalane							
$N\text{-}C_6H_{14}$			8				8
$N\text{-}C_7H_{16}$			3				3
Toluene			15				14
$N\text{-}C_8H_{18}$			3				2
$E\text{-}C_6H_5$			6				6
M-XYL			18				15
O-XYL			8				5
$N\text{-}C_9H_{20}$			1				1
$N\text{-}P\text{-}H_5$			1				1
$N\text{-}C_{10}H_{22}$			4				3
Beckman 6800							
THC	2000		2620	2500	2100	2150	2720
CH_4	1450		1710	1580	1450	1500	1770
CO	300		1070	840	430	470	980

(continued)

TABLE C-15 (continued)

Date	11/18/76 9-11	11/18/76 11-13	Bag Box 1 11/18/76 13-15	Tank 11/18/76 13-15 (Upwind)	Bag Box 2 11/18/76 13-15
Dura Pak					
C_2H_6	65.1	48.4	28.1	27.9	27.8
C_2H_4	74.7	65.6	35.1	6.9	19.6
C_3H_8	91.2	65.7	35.2	35.5	35.2
C_2H_2	26.1	11.1	5.7	5.7	6.7
$IsoC_4H_{10}$	24.3	16.5	11.0	10.6	10.8
$N\text{-}C_4H_{10}$	85.5	55.8	40.2	36.9	36.7
C_3H_6	7.0	4.5	1.3	2.6	1.0
$IsoC_5H_{12}$	46.0	27.0	21.0	18.0	21.0
$N\text{-}C_5H_{12}$	27.0	14.0	10.0	8.0	6.0
Squalane					
$N\text{-}C_6H_{14}$				30	21
$N\text{-}C_7H_{16}$				1	1
Toluene				10	12
$N\text{-}C_8H_{18}$				1	1
$E\text{-}C_6H_5$				5	6
M-XYL				17	19
O-XYL				5	5
$N\text{-}C_9H_{22}$				1	1
$N\text{-}P\text{-}C_6H_5$				1	1
$N\text{-}C_{10}H_{22}$				2	2
Beckman 6800					
THC	3020	2580	2350		2270
CH_4	1830	1710	1580		1560
CO	1610	690	450		410

APPENDIX D

SPECIAL STUDIES

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D.0 INTRODUCTION

Appendix D contains the results obtained from special studies in table form in order to provide an overview of the data.

TABLE D-1. ROADWAY SAMPLES COLLECTED AND ANALYZED 9/22/76 *

	Babler Park # 5	Babler Park Repeat	Manchester Road	Ultrapure Air	Interstate 40
Dura Pak					
C_2H_6	4.1	3.7	22.3	0.3	18.9
C_2H_4	5.2	5.4	157.1	2.2	127.3
C_3H_8	5.7	5.3	27.6	0.3	14.4
C_2H_2	3.0	3.2	111.5	0.9+	83.2
$IsoC_4H_{10}$	0.8	0.8	15.2	BDL**	11.3
$N\text{-}C_4H_{10}$	3.4	3.3	84.1	1.2	62.7
C_3H_6	1.8	1.4	73.7	0.7	60.3
$IsoC_5H_{12}$	1.7	1.8	125.0	0.6	84.0
$N\text{-}C_5H_{12}$	1.5	1.5	68.0	BDL**	41.0
Squalane					
$N\text{-}C_6H_{14}$			46.0	NM+	64
$N\text{-}C_7H_{16}$			15.0	NM+	32
Toluene	6		72.0	9	165
$N\text{-}C_8H_{18}$	1		12.0	Trace	16
$E\text{-}C_6H_5$	9		30	10	68
M-XYL	30		78	33	136
O-XYL	4		30	6	65
$N\text{-}C_9H_{20}$	Trace		4	Trace	4
$N\text{-}P\text{-}C_6H_5$	BDL**		5	1	6
$N\text{-}C_{10}H_{22}$	NM+		16	1	NM+
Beckman 6800					
THC	1930		4010	210	3450
CH_4	1850		2270		1960
CO	290		7850	240	6510

* Concentrations in ppbC
** Below detection limits
+ Not measurable (because of interference etc.)

(continued)

TABLE D-1 (continued)*

	Interstate 270	Babler Duplicate
Dura Pak		
C_2H_6	42.0	4.6
C_2H_4	253.0	5.6
C_3H_8	54.9	5.6
C_2H_2	190.1	3.3
$IsoC_4H_{10}$	19.8	0.8
$N\text{-}C_4H_{10}$	121.4	5.3
C_3H_6	112.7	1.8
$IsoC_5H_{12}$	159.1	2.9
$N\text{-}C_5H_{12}$	79.7	1.5
Squalane		
$N\text{-}C_6H_{14}$	38	
$N\text{-}C_7H_{16}$	51	
Toluene	239	
$N\text{-}C_8H_{18}$	45	
$E\text{-}C_6H_5$	107	
M-XYL	277	
O-XYL	91	
$N\text{-}C_9H_{20}$	21	
$N\text{-}P\text{-}C_6H_5$	18	
$N\text{-}C_{10}H_{22}$	41	
Beckman 6800		
THC	6250	
CH_4	3280	
CO	11360	

* Concentrations in ppbC

TABLE D-2. ROADWAY SAMPLES COLLECTED 9/22/76 ANALYZED 9/24/76*

	I-270	I-40	Manchester Road	Ultrapure Air	I-270 Duplicate
Dura Pak					
C_2H_6	47.1	19.1	22.2	0.4	40.8
C_2H_4	280.1	121.0	148.6	2.8	242.6
C_3H_8	61.5	14.2	26.7	0.4	53.1
C_2H_2	208.2	78.0	99.5	0.6	184.8
$IsoC_4H_{10}$	24.2	11.1	14.5	0.2	20.3
$N\text{-}C_4H_{10}$	138.3	61.3	80.6	1.4	118.5
C_3H_6	125.0	57.3	76.0	0.9†	108.6
$IsoC_5H_{12}$	191.0	81.0	119.0	0.7	165.0
$N\text{-}C_5H_{12}$	85.0	38.0	64.0	0.7	77.0
Squalane					
$N\text{-}C_6H_{14}$	89	27	41	1	
$N\text{-}C_7H_{16}$	28	14	15	1	
Toluene	140	67	73	12	
$N\text{-}C_8H_{18}$	25	12	14	2	
$E\text{-}C_6H_5$	66	37	36	16	
M-XYL	131	90	92	53	
O-XYL	56	32	36	10	
$N\text{-}C_9H_{20}$	10	1	4	NM †	
$N\text{-}P\text{-}C_6H_5$	10	2	5	NM †	
$N\text{-}C_{10}H_{22}$	25	5	9	NM †	

* Concentrations in ppbC
† Not Measurable (because of interference etc.)

TABLE D-3. ROADWAY SAMPLES COLLECTED AND ANALYZED 9/27/76 *

	Bag 3 No. on 270	Bag 3 N. on 270 Repeat	Bag 1 West on Manchester	Bag 4 West on Olive	Bag 5 N. on 270 (Olive-Page)	Bag 1 (Dupl) West on Manchester
Dura Pak						
C_2H_6	38.6	38.4	16.1	17.1	21.4	16.0
C_2H_4	306.6	305.3	94.0	72.9	115.9	93.9
C_3H_8	16.6	16.6	12.0	12.4	14.1	12.2
C_2H_2	355.4	361.0	105.5	68.7	67.1	109.6
$IsoC_4H_{10}$	33.5	33.0	12.0	8.4	13.3	12.0
$N\text{-}C_4H_{10}$	180.3	179.1	57.6	32.0	60.8	57.5
C_3H_6	141.2	141.4	39.1	26.4	49.0	39.2
$IsoC_5H_{12}$	136.0	243.0	75.0	38.0	73.5	60.0
$N\text{-}C_5H_{12}$	135.0	134.0	42.0	19.8	43.4	36.4
Squalane						
$N\text{-}C_6H_{14}$	91		45	30	27	
$N\text{-}C_7H_{16}$	31		11	6	11	
Toluene	126		44	30	51	
$N\text{-}C_8H_{18}$	21		52	6	10	
$E\text{-}C_6H_5$	55		93	14	22	
M-XYL	123		88	40	98	
O-XYL	61		27	14	22	
$N\text{-}C_9H_{20}$	6		135	2	3	
$N\text{-}P\text{-}C_6H_5$	22		894	6	5	
$N\text{-}C_{10}H_{22}$	16		4331	3	5	
Beckman 6800						
THC	6000		9000	2900	3500	10020
CH_4	1910		1800	1850	1940	1840
CO	14600		5850	5190	5540	5890

* Concentrations in ppbC

TABLE D-4. ROADWAY SAMPLES COLLECTED AND ANALYZED 10/29/76*

	W. on Manchester I-270 to Weidman	W. on Manchester Weidman to Ries	S. on I-270 Manchester to I-44
Dura Pak			
C_2H_6	36.1	53.6	33.0
C_2H_4	215.1	259.1	207.9
C_3H_8	47.0	40.5	48.5
C_2H_2	205.4	257.8	134.7
Iso-C_4H_{10}	32.0	33.0	19.9
N-C_4H_{10}	153.3	194.3	114.8
C_3H_6	95.6	114.1	93.7
IsoC_5H_{12}	145.2	182.6	116.7
N-C_5H_{12}	61.4	75.8	62.9
Squalane			
N-C_6H_{14}	38	74	44
N-C_7H_{16}	19	25	20
Toluene	94	119	83
N-C_8H_{18}	12	20	20
E-C_6H_5	38	41	24
M-XYL	90	129	74
O-XYL	47	52	41
N-C_9H_{20}	5	8	31
N-P-C_6H_5	7	12	6
N-$C_{10}H_{22}$	9	15	NM**
Beckman 6800			
THC	5230	6410	5000
CH_4	2350	2690	2090
CO	12360	15660	8970

* Concentration in ppbC

** Not measurable (because of interference etc.)

(continued)

TABLE D-4 (continued)*

	W. on Olive I-44 to Manchester	W. on Olive I-270 to Eatherton	Dupl. Analysis W. on Manchester I-270 to Weidman
Dura Pak			
C_2H_6	29.8	5.3	37.3
C_2H_4	206.0	6.6	220.4
C_3H_8	42.3	11.8	47.8
C_2H_2	127.4	5.8	208.4
Iso-C_4H_{10}	17.1	2.2	33.0
N-C_4H_{10}	95.5	7.7	156.8
C_3H_6	95.9	2.4	95.2
IsoC_5H_{12}	99.5	9.8	148.9
N-C_5H_{12}	51.0	2.2	61.0
Squalane			
N-C_6H_{14}	28	BDL	38
N-C_7H_{16}	15	1	21
Toluene	68	5	99
N-C_8H_{18}	10	2	13
E-C_6H_5	21	3	32
M-XYL	62	5	88
O-XYL	34	5	39
N-C_9H_{20}	4	1	5
N-P-C_6H_5	9	NM**	3
N-$C_{10}H_{22}$	14	NM**	8
Beckman 6800			
THC	4290	2030	- -
CH_4	1990	1720	- -
CO	9580	350	- -

* Concentration in ppbC

** Not measurable (because of interference etc.)

TABLE D-5. C_2H_4 BAG SAMPLES AT STATION 101 COLLECTED & ANALYZED 10/22/76*

	Dura Pak C_2H_6	C_2H_4	C_3H_8	C_2H_2	ISO-C_4H_{10}	N-C_4H_{10}	C_3H_6	ISO-C_5H_{12}	N-C_5H_{10}
BAG BOX 7-8	27.7	70.7	17.6	62.1	23.8	117.5	26.3	97.0	51.0
BAG BOX (REPEAT) 7-8	27.7	70.7	17.5	60.8	22.8	116.7	24.5	96.0	53.0
AUTO (UPWIND) 7-8	29.7	61.1	26.0	68.4	79.2	485.8	26.8	231.0	103.0
BAG BOX 8-9	24.0	71.6	19.8	57.3	28.6	143.0	23.4	107.0	52.0
AUTO (UPWIND) 8-9	21.9	53.8	19.1	53.7	21.9	98.4	25.3	91.0	48.0
Between PUMP BOX and BAG BOX 9-10	12.7	1740.5	18.0	21.5	17.5	134.7	8.4	58.0	29.0
CENTERMOST BLOWER OUTLET 10-11	11.0	9199.4	34.4	8.2	12.0	55.9	5.0	38.0	12.0
INOPERATIVE BLOWER OUTLET 11-12	8.2	92.9	16.0	10.1	7.6	27.7	3.6	21.0	10.0
OUTLET OF VACUUM PUMP 12-13	22.6	9042.8	32.9	11.6	7.7	32.2	17.5	24.0	12.0
PUMP BOX INTERIOR 13-14	9.5	1486.1	20.1	12.0	12.5	105.3	6.6	39.0	14.0
BAG BOX (DUPLICATE) 7-8	28.2	72.5	17.2	62.7	22.5	116.0	25.7	98.0	54.0

* Concentrations in ppbC

TABLE D-6. ETHYLENE BAG SAMPLING AT STATION 101 (WITH AIR SAMPLING PUMP)*

	C_2H_6	C_2H_4	C_3H_8	C_2H_2	ISO-C_4H_{10}	N-C_4H_{10}	C_3H_6	ISO-C_5H_{12}	N-C_5H_{12}
BAG 1 9-9:15	22.1	36.1	31.2	33.5	27.9	430.2	15.0	84.0	25.0
BAG 1 9-9:15	22.1	35.9	31.2	33.5	27.9	427.4	15.0	82.0	25.0
TANK 1 9-9:15	20.3	271.0	30.4	31.3	27.1	418.8	13.0	73.0	26.0
BAG 2 10:10-10:15	13.7	28.9	20.0	18.5	21.6	207.7	8.0	65.0	25.0
TANK 2 10:10-10:15	13.2	21.9	20.4	19.2	20.8	223.4	8.0	59.0	30.0
BAG 3 10:45-11	10.1	108.2	12.6	12.5	11.7	65.7	5.0	40.0	14.0
TANK 3 10:45-11	9.5	13.0	12.0	12.4	11.7	64.5	5.0	39.0	18.0
BAG BOX (NO PUMP) 9-11	16.6	1765.4	24.9	29.3	23.5	259.5	11.0	75.0	24.0
BAG 1 9-9:15 Duplicate	21.6	36.4	31.3	34.3	27.6	431.5	14.0	77.0	30.0

* Concentrations in ppbC

Collected and Analyzed 11/2/76

TABLE D-7. ETHYLENE BAG SAMPLING AT STATION 124 (WITH AIR SAMPLING PUMP)*

	Dura Pak								
	C_2H_6	C_2H_4	C_3H_8	C_2H_2	ISO-C_4H_{10}	N-C_4H_{10}	C_3H_6	ISO-C_5H_{12}	N-C_5H_{10}
BAG 2 10-10:30	4.3	7.5	4.8	1.6	0.8	4.4	0.7	4.0	2.0
BAG 2 (REPEAT) 10-10:30	4.5	7.5	4.8	1.9	1.1	4.5	0.7	4.0	2.0
TANK 2 10-10:30	4.5	6.2	5.6	2.6	2.0	4.0	1.1	5.0	3.0
BAG 3 10:45-11:10	4.5	7.9	4.4	1.5	0.9	3.3	0.7	3.0	2.0
TANK 3 10:45-11:10	4.5	4.5	4.0	1.9	0.8	2.3	0.9	2.0	2.0
BAG 4 (BAG BOX - NO PUMP) 10-11:15	4.7	21.4	4.8	1.2	1.3	7.2	1.0	5.0	2.0
TANK 1 (OUTSIDE AIR) 9:30-9:45	4.4	2.2	5.8	2.0	2.0	15.2	1.1	4.0	2.0
BAG 5 (STATION AIR)	5.8	2716.8	7.2	1.9	1.6	6.0	1.1	2.0	2.0
BAG 2 (DUPLICATE) 10-10:30	4.3	7.3	4.9	1.6	0.6	4.2	0.7	4.0	2.0

* Concentrations in ppbC

Collected and Analyzed on 11/3/76

TABLE D-8. ETHYLENE BAG SAMPLING AT STATION 124 (WITH AIR SAMPLING PUMP)*

	Dura Pak C_2H_6	C_2H_4	C_3H_8	C_2H_2	ISO-C_4H_{10}	N-C_4H_{10}	C_3H_6	ISO-C_5H_{12}	N-C_5H_{12}
BAG 2 9:55-10:10	5.4	11.4	4.7	4.9	2.2	8.8	2.0	9.0	3.0
BAG 2 (REPEAT) 9:55-10:10	6.1	11.3	4.7	3.8	1.5	8.5	1.0	8.0	3.0
TANK 2 9:55-10:10	5.2	8.1	4.3	4.5	1.4	5.4	1.0	4.0	2.0
BAG 3 10:45-11	4.7	9.4	3.8	3.3	1.7	7.1	3.0	4.0	3.0
TANK 3 10:45-11	4.7	8.6	3.6	2.8	1.1	4.1	1.0	3.0	3.0
BAG 4 (STATION AIR -1) 10:20-10:45	5.2	2018.2	7.8	4.1	1.9	8.8	2.0	6.0	
TANK 1 (AIR UPWIND OF STATION)	5.5	4.2	5.4	3.5	4.1	34.2	2.0	16.0	3.0
BAG 5 (BAG BOX-NO PUMP) 9:30-11	5.3	13.8	4.7	4.5	1.6	6.9	2.0	4.0	2.0
BAG 6 (STATION AIR -2 LEE SIDE OF STATION)	4.6	923.5	5.3	3.5	1.4	5.7	1.0	3.0	2.0
TANK 4 (AIR UPWIND OF STATION)	4.7	3.3	4.2	3.0	2.2	19.1	2.0	11.0	4.0
BAG 2 (DUPLICATE) 9:55-10:10	5.3	11.4	4.6	4.3	1.7	8.1	1.0	5.0	3.0

* Concentrations in ppbC

Collected and Analyzed 11/4/76